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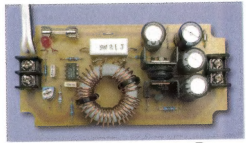

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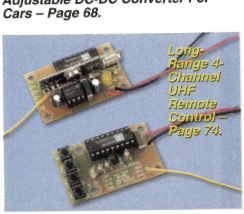

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PUBLISHER'S LETTER

Low voltage halogen lamps are huge power wasters

In the eyes of many people, halogen lamps are a thing of beauty, a jewel-like pinpoint giving an intense white light that makes shiny objects sparkle and gleam. They also give an uncluttered look to the low-slung ceilings of modern homes because conventional hanging light fittings are not practical. In short, halogen lamps are the "fashion" lighting accessory in modern homes.

But they are awful power wasters. Recently, I visited some older relatives of mine in their sparkling, new home. And yes, every room was lit by halogen lamps recessed into the ceilings. Well, I hate 'em, so I did not comment on this feature. However, later on during my visit, the man of the house happened to mention that their electricity bills were very high; much higher than in their previous home. He also said that their new home was much hotter than their previous home and so they had to run the whole house air-conditioner for much of the previous summer. He put the high power bill down to the air-conditioner. No doubt, he was mainly correct in this assumption but he had not thought about the halogen lamps.

Each room was lit by four 50W halogen lamps and because (as in most modern housing developments) the house is cheek-by-jowl with neighbouring dwellings, they don't get a lot of natural light and so tend to leave the lights on in several of the rooms for much of the day. And I daresay, as in many homes, the place is lit up like a Christmas tree at night. So the power consumption of their sparkly halogen lamps is consistently high. When I remarked that halogen lamps are power wasters, he replied that he understood that they were "efficient because they run at low voltage".

This sort of misconception makes me grind my teeth in frustration. I even think that this misconception is deliberately encouraged by some companies, to sell more of their wasteful lamps!

Well, let's thoroughly debunk that misconception. Low voltage does not mean low wattage! Low voltage is not good just because it is low voltage.

Yes, it is true that halogen lamps run at low voltage - ie, 12V. But a 50W lamp still draws 50 watts, regardless of the running voltage. Furthermore, the stepdown transformers used to run halogen lamps are notoriously inefficient. I would estimate their efficiency at around 80% at best - that is why they run so stinking hot! And that is why installers are warned that halogen lamp transformers need plenty of ventilation and must not be crowded in amongst ceiling rockwool insulation.

So rather than each 50W halogen lamp drawing 50 watts, the total draw is around 63W. And because they do have a narrow beam, you need more of them to light a room. So if you have four rooms, each lit with four 50W lamps, the total draw is around 1000 watts. That's the same as a single-bar radiator!

So say my relatives have four rooms in the house lit most of the day (seven hours) and six rooms run for an additional five hours in the evening. That's a total daily lighting consumption of around 14-15 kilowatt-hours. That's a lot of heat. That also means that the air-conditioner has to work so much harder to remove it. All told, their overall consumption due to halogen lighting probably averages around 20kWh every day. Over three months, that will cost at least $180 dollars or $720 per annum.

They could cut that in half by merely switching off lights in the rooms they are not using. And they could further cut it by using more conventional incandescent and fluorescent lighting. So much for the cost of lighting "fashion". Across Australia there are tens of millions of halogen lamps, in homes and shopping centres. They are an ecological disaster.

Leo Simpson

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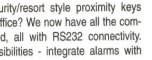
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MAILBAG

Crook electric wiring

I couldn't agree more with the sentiments expressed in your Publisher's Letter (March 2003) about dodgy electrical wiring. We have just had a 3-storey building refurbished and rewired by professional electricians. To describe their work as a "pigs' breakfast" would be too good for it. This is fast becoming the rule rather than the exception in jobs I've seen lately.

In days of old, sparkies were required to be relatively neat in their work, however work standards seem to have started to really go down hill since late 1998. In this particular project, wires are held up above the new suspended ceiling via disused old suspended ceiling eyes, clipped every metre if you're lucky. TPS cable is hanging down to the 3-pin troffer lighting sockets which are slung in mid-air. On the upper floor, the cabling runs above the safety wire mesh that is below the insulated sarking under the roof. Not to mention the new TPS building cable that has about half the insulation of the old stuff!

Those unlicensed people such as electronics technicians, etc who know how to change a power point or run an additional circuit are in danger of being found out simply by the fact that their work is **too neat and tidy**!

Where's this all going to lead? I don't know but one thing is for sure and that is that no pro sparkie can bleat about unsafe wiring practices if what I've seen recently is what is now the normal standard produced by these people.

Name supplied and withheld at writer's request.

Bureaucracy gone mad

I am writing with regard to the issue of the Queensland contractors electrical licence required for electronics repairers and the Publisher's Letter in the March issue concerning the proposed banning of electrical cables, switches, power points, etc from public sale in Victoria.

This is bureaucracy gone mad and is a direct result of the apathy that pervades our society. Having worked in the medical industry, I have witnessed first hand what happens when bureaucrats get involved with a system that has previously worked well.

All bureaucrats work on the same lines of reasoning. We must protect you as a consumer from the unscrupulous or from yourselves. We are here only for your good. This sounds wholesome but they are there for the purpose of regulation and control, to gather revenue and to perpetuate their organisation.

These new regulations in Queensland smack of restrictive and anti-competitive work practices and government-sanctioned monopoly. It may be quite illegal and should perhaps be tested in the High Court of Australia.

Unfortunately, we as techo's are a politically inert lot, more satisfied at wielding the soldering iron and oscilloscope probe than the pen, much to our detriment.

Also, the Restricted Electrical Licence should be beefed up a little and be available to technicians having completed recognised courses in electronics – so as to legally enable them to carry out their professions and be permitted to carry out electrical wiring in their own homes. Basic electrical wiring is child's play to a qualified technician.

Finally, is Australia a truly democratic, free enterprise clever country or are we becoming a grossly over-regulated society?

M. Whitenight, via email.

ETI-480 amplifier a faithful old dog

In your articles on the SC480 (January & February 2003) you say that the ETI-480 Amplifier Module was a "dog" of an amplifier and that it was not a good performer, but there is another view. I'm a bass guitarist and since 1986 I've used a pair of ETI-480s running in bridge mode. Two dogs are usually better than one and this is definitely true with these modules. Together they run a full 100W RMS into an 8Ω heavy-duty 38cm loudspeaker.

I've done many hundreds of gigs with them; they've been faithful companions and have never let me down. However, they do develop a bit of a smell during the warmer months. I was a bit stingy with heatsinks and the specified 1W rating was never going to be sufficient for R16 and R17, the 33Ω emitter resistors for the driver transistors. I've since replaced them with two 68Ω 1W units in parallel.

Several years ago, I tried upgrading to a higher-powered MOSFET module and a much bigger power supply but it sounded too pure, too tight, too dead for my setup. It felt like trying to play golf with a set of clubs whose shafts had no "whip".

The MOSFET module works much better for vocal PA and I'm still using the 480s for bass. I would really love to build the new SC480 module but there's every chance that the old dogs will outlive their master.

Neil Hobbs, Mitcham, Vic.

Piano tuners need an electrical contractor's licence in Qld

I am very concerned about needing an electrical contractor's licence to do electronic repairs.

In 1976, I gained my Electrical Fitter Mechanic certificate, after a 4-year apprenticeship with O'Donnell Griffin in Concord West. I studied at Penrith Technical College and then at West Sydney Technical College in Petersham.

After a year and a half more with the company, I left to change direction and gained my Certificate in Piano Tuning and Technology at the NSW State Conservatorium of Music in 1981.

I've now been working in piano serv-

icing and technology for 23 years. During that time I've noticed electronics and 240V entering into pianos. Usually, this is a computer-based system or a climate control system. Sometimes it may be for show or display lighting.

The computer types can be a disk recording playback system, or for silent practice, digital piano circuitry can be added to some pianos so one can hear the piano in headphones while the piano's hammers are stopped short of hitting the strings.

Secondly, 240V gear can be found in pianos, where a humidifier or dehumidifier has to be installed. Both computer and climate systems can be found in uprights and grand pianos.

So, under the proposed new rules, where do I stand? Should I have the qualifications to renew plugs, sockets, etc and check safety? Presumably there should be some provision for people like me to show a certificate and be able to buy fittings from an electrical supplier.

Paul Smith,
Albert Park, Vic.

Comment: at the moment, the electrical contractor licence requirement only applies in Queensland. But the legislation there needs killing before it spreads to other states.

Exploding motherboard capacitors hard to replace

I just read your article about exploding motherboard capacitors in the May 2003 issue. Unfortunately, it came a little too late. I manage the network for an Internet cafe and I recently diagnosed the capacitor problem on 20 of our motherboards. I read your article and you have covered the problem but not enough about the solution.

You mentioned the low ESR capacitors you can buy from RS but unfortunately they were all too big to fit on these boards (about 20 capacitors need replacing on each board). I imagine that most motherboards will have a similar problem as everything is squashed in as close as possible.

After many interstate phone calls and confused sales people, I found a suitable replacement. The Rubycon ZLH series provide a range of 1500µF capacitors which I managed to be able to get in an 8mm package from Tenrod Australia – see **www.tenrod.com.au** for contact details. The capacitors cost 60c each.

If enough people need these replacements Tenrod may reduce their minimum order quantities to make it a bit more accessible to someone with just one motherboard to fix.

Hope this helps!
Aaron Russell,
via email.

Shotgun service techniques not desirable

As I read the Serviceman's Log each month, I am concerned at the "shotgun" techniques used. If there is something wrong with the sound, he will simply change every component in that section. This is usually without any attempt to trace the fault.

Maybe this is normal practice these days but it reeks of the old "valve-jockey" approach where a junior employee would exchange valves in the hope of fixing something.

Sets that failed to be fixed like this were then passed to an "expert" for serious diagnosis. The man makes a living I guess but should this approach be recommended to readers by publishing accounts of it?

Mike Murphy,
by email.

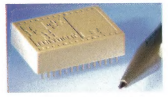
Comment: the Serviceman stories "tell it like it is" but we will let our Serviceman reply in person:

I think it has been said before that the definition of an engineer is someone who can make or do something for 10c that any damn fool can do for $1. Nowadays it is all about money and being cost-effective. Time is of the essence. You might be a genius and muddle it all out in your head before you fix it, and take all day doing so, or you might just change a few choice components that cost only a few cents each in five minutes.

However, there are some tenacious faults that just won't reveal themselves by careful measurement and diagnosis, particularly those intermittent ones. I think it unfair to use the sentence "usually without any attempt to trace the fault".

Furthermore, a faulty part can sometimes damage surrounding components and from a warranty point of view, it is only sensible to change all

The Tiger comes to Australia



The BASIC, Tiny and Economy Tigers are sold in Australia by JED, with W98/NT software and local single board systems.

Tigers are modules running true compiled multi-tasking BASIC in a 16/32 bit core, with typically 512K bytes of FLASH (program and data) memory and 32/128/512 K bytes of RAM. The **Tiny Tiger** has four, 10 bit analog ins, lots of digital I/O, two UARTs, SPI, I²C, 1-wire, RTC and has low cost W98/NT compile, debug and download software.

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Www.jedmicro.com.au/RS485.htm

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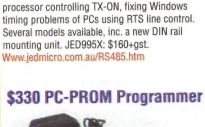

This programmer plugs into a PC printer port and reads, writes and edits any 28 or 32-pin PROM. Comes with plug-pack, cable and software.
Also available is a multi-PROM UV eraser with timer, and a 32/32 PLCC converter.

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the related parts. If you only change the one faulty part and not the other vital components, the system may run but not to specifications, leading to further failure.

Long experience and training gives one the knowledge to recognise common component failures that might not require too much research to pinpoint the fault. I'm sure most people would prefer to pay for the cheapest approach and they don't really care if it is scientific or shotgun.

It never rains but it bores

I found your PIC-based Rain Gauge in the September 2000 issue an interesting project, though I didn't build it for its original use. I wanted a controller for a bore pump. The pump has to fill two large tanks, if possible using only off-peak electricity. An added complication is that the pump can only run for six hours at a time otherwise the bore may run dry. If more than six hours pumping is required, it has to run during the day as well as at night.

Using the PIC gave me the opportunity to log the time that the pump took each day to fill the tanks and store this information for 61 days, as in the Rain Gauge.

In modifying and adding to the program, I found the source code very easy to follow, well commented and clearly laid out. In the hardware, you kindly left me one output bit unused that I required to control the pump, that 7th segment in the bargraph. Thanks for a great project.

Keith Gooley,
via email.

Project discrimination against front-wheel drive cars

As a subscriber and reader of your magazine over the years it has come to my attention that us owners of front-wheel drive cars (which these days are probably the majority) are being discriminated against when you publish automotive projects.

Any project is usually only designed and described for a tail-shafted car; ie, rear-wheel drive. I realise it is more difficult to put sensors on front-wheel drive cars but as there are not that many rear-wheel drive cars on the market any more maybe you could put your thinking caps on and come up with a solution. The latest project, the "Triptronic Gear Indicator" in January 2003, is but one example.

Ray Draper,
Canberra, ACT.

Comment: what a grievous accusation. We would never discriminate in such a way. In truth, while the diagrams may show a speed pickup attached to a tailshaft, exactly the same method can be employed with front wheel half-shafts, although it is more difficult.

In any case, in the Gear Indicator article you refer to, on page 43 we describe how to use the speed signal from the engine management computer. Virtually every front-wheel drive car produced in the last 20 years will have an engine management computer.

CRC 2-26 can catch fire

I write in response to a letter about WD-40 in Mailbag in the March 2003 issue. I agree with John (don't use WD-40), that WD-40 is a penetrating oil never designed for electronic use. Conversely, I do not agree that CRC 2-26 is NOT flammable. I once washed the engine of my car and pretty much saturated the distributor, inside and out, with CRC 2-26 when the ignition got wet and the engine wouldn't start.

Once it did start, within a moment I noticed a burning smell and a little smoke from under the (still open) bonnet. I discovered my distributor on fire! It was only burning for a moment and no damage was done except to some plug lead insulation, and a rag thrown over it soon put it out.

Significantly, no other product had been used on the distributor except CRC and obviously there were no residues from previous servicing, otherwise the distributor would have caught fire beforehand. There is no doubt the CRC 2-26 ignited, yet subsequent attempts to ignite a little of the liquid with a match failed and the container does say it is non-flammable.

My only conclusion is that it ignited maybe because the temperature or intensity of the arcing within the distributor was hotter than a match flame. I don't know.

Importantly, many of the water dispersant type products sold for auto use are oil-based, particularly the cheap products from discount stores, yet while they may be marked as flammable, they give no cautions about the potential for the incident I experienced.

Indeed, one such product I use is Australian Export WD Spray as a general anti-rust product and while the can is marked as flammable gas (which I suggest is incorrect labelling), it is indicated on the can that the product "acts fast to start wet engines". This product is distributed by Oweno Sales, NSW.

Incidentally, I was once advised by a mechanic not to use these types of products on tools to prevent rusting, since they are hygroscopic (absorb water) and therefore will attract water in a humid atmosphere and actually cause rust, rather than prevent it!

Peter Cahill,
via email.

Isolation of CHMSL lamp failure circuit

Those readers building the LED centre high-mount stop light (CHMSL) from the March 2003 issue may be interested in the following. On a 1991 Camry/Apollo, this circuit can be isolated by removing one 2.2kΩ resistor from the PC board in the Lamp Failure Box which can be found in the righthand side of the boot. It can be unplugged from the wiring harness and is easily dismantled.

There are three 2.2kΩ resistors which go to the sensing circuit on the PC board, one for Stop, one for CHMSL and one for Tail and Number (combined). Identify the CHMSL and remove the appropriate resistor; all other functions remain unchanged.

Readers with similar vehicles may like to try this modification.

R. Sonter,
Bundaberg, Qld. SC

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06-03

2003 Mars Rovers

NASA's next mission to Mars

Ever since the first fly-by of Mars in 1965, the red planet has captured the imagination of scientists and explorers worldwide. The 1997 landing of the Pathfinder Mission further inspired the world with footage from the Rover as it traversed the rocky surface of Mars. Six years on, NASA/JPL are set to launch two bigger and smarter Rovers to continue the exploration.

The Mars Exploration Rover Mission is part of NASA's long-term series of missions to undertake robotic exploration of the surface of the planet.

This month's launch of the mission will take advantage of the periodic alignment of various planets which occurs every 26 months.

This mission will have numerous scientific instruments but it primarily seeks answers about water on Mars. This fits into the four objectives of the long term Mars Exploration Program:

(a) to determine if life ever existed on Mars;

(b) Characterisation of the climate of Mars;

(c) Characterisation of the surface of Mars and

(d) Preparation of scientific knowledge for potential future human exploration of Mars.

Two separate Boeing Delta II launch rockets, each carrying a Mars Rover exploration vehicle, will be launched from Cape Canaveral, Florida, between 30th May and 12th July 2003. The spacecraft will arrive at Mars during January 2004.

Rover A, to be launched between 30th May and 16th June, is currently planned to arrive on 4th January 2004. Rover B, to be launched shortly afterwards (between 25th June and 12th July), is set to arrive on 25th January 2004.

The Rover vehicles will land on two separate sites on the Martian surface.

By Sammy Isreb

Ahh. . . it's good to see the boffins at the JPL have a sense of humour . . . or is that face to scare the Martians? Here's one of two Rovers being packaged ready for blast-off on a Delta II launch vehicle, planned for this month. (NASA/JPL)

After leaving the Earth's gravitational pull, the spacecraft will separate from the Boeing Delta II launch vehicle. The craft measures around 2.65m in diameter and 1.6m in height, with a mass of 1063kg. The structure is comprised primarily of aluminium ribs, covered by solar panels. The panels generate around 600W of power shortly after leaving Earth, dropping to around 300W on approach to Mars.

A complex system is used to regulate the temperature of vital components inside the craft during the cruise stage. Heaters and multi-layer insulation are employed in order to keep the spacecraft electronics warm, with a Freon system used to pump heat from the core of the flight computer and telecommunications equipment.

Like all spacecraft, an onboard navigation system and a compensatory propulsion system are used for numerous trajectory correction manoeuvres. In order to determine when a trajectory correction is necessary, the Star Scanner and Sun Sensor is used. This allows the spacecraft's flight computer to determine its location by using the sun and various stars as references.

If a corrective burn is required, various thrusters use a hydrazine propellant. This is carried in two tanks with a total capacity of 31kg. During flight, the craft is spin-stabilised at around 2rpm. Occasionally, the orientation of the craft will be altered by thruster burns to ensure the appropriate spin rate and that the antennas are directed towards the Earth and the solar panels towards the sun.

The communications system has several modes to enable reception and transmission of data to Earth. The Deep Space Network is used on Earth to communicate with both craft and, later on, the Rovers. A low gain antenna is used in the early part of the mission near Earth. As the distance increases, a switch will be made to a medium gain antenna.

Arrival at Mars

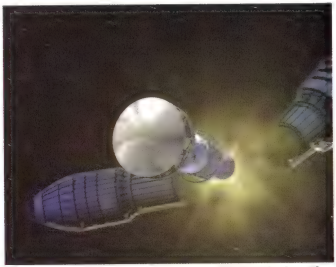
As the craft enters the Martian atmosphere the Aero Shell and Retro-rocket assembly will slow it from over 16,000km/h to around 1600km/h within one minute.

Central to the survival of the descent is the heat shield portion of the Aero Shell, which is primarily an aluminium honeycomb structure sandwiched between graphite epoxy sheets. The shield is coated with a phenolic compound impregnated with corkwood and tiny silica glass spheres, which react with the Martian atmosphere to dissipate heat from the structure, leaving a wake of hot gas.

After the initial atmospheric braking, about 10km above the surface of Mars a parachute is deployed and the heat shield jettisoned.

Because the Martian atmosphere is only about 1% as dense as that on Earth, the parachute assembly does not slow the craft down enough to permit a safe landing. For this reason,

Stowed in the nose cone of a Delta II rocket, the two Mars Exploration Rovers blast off this month from the Kennedy Space Center in Florida.



The nose cone of the rocket separates during the launch phase and the Mars Exploration Rover is sent on an eight-month journey to Mars.

a technique known as Rocket Assisted Descent (RAD) is used.

Three RAD motors (solid state rockets) provide over one tonne of reverse thrust for around two seconds. These are fired to bring the craft to a stop about 10 or so metres above the surface. The craft then drops but just before it hits the surface, numerous airbags encasing the Lander will be inflated. The inflated Lander structure will then bounce along the surface, rolling to a stop.

A radar altimeter unit is used to determine when to deploy the parachute, when to release the chute, when to fire the RAD rockets and finally, when to deploy the airbags.

Shortly after landing, the airbags will be deflated, the Rover will emerge, unfurl its petal-like solar panels and commence the ground-based portion of the mission.

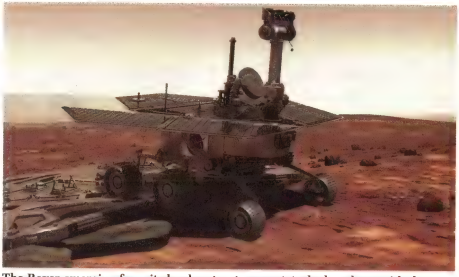
Rover deployment

Inside the protective airbags is the Lander structure which houses the Rover. The structure consists of a tetrahedron base, with three "petals" folded up to create a pyramid.

These petals are hinged, with a motor driving each hinge, so that the pyramid will be unfolded upon landing (to form a flat structure). Each motor is strong enough to lift the entire assembly, so that the Lander will be unfolded to its desired position, irrespective of which side it initially falls on.

The Rover is secured in the Lander with special bolts, which contain explosive charges to unshackle it from its storage position. The Rover will then roll down specially built ramps on the petals, which protect it from getting tangled up in the remains of the airbags, or falling and being damaged.

It is estimated the time taken from when the Lander touches down to the time the Rover rolls onto the Martian soil will be about three hours.



The Rover emerging from its lander structure – a tetrahedron base with three petals which fold up to create a pyramid. No matter which way up it lands, strong motors on the petals will turn it right-side-up. (NASA/JPL)

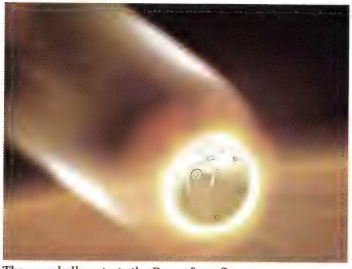
The Rover

The Rover has six 25cm wheels, each driven by its own motor. The front and back two wheels have their own steering motors, to allow the Rover to turn a full 360° on the spot. This is designed to allow the Rover to escape any tight situations it may find itself in.

The suspension setup is known as a "rocker-bogie" system which can swivel its wheels to arc around corners. Rocker suspension systems prevent the vehicle from moving up or down a great deal whilst traversing rocky terrain and even out the weight distribution across all wheels. Through careful weight distribution and the advanced suspension system, the Rover can withstand being tilted to 45° in any direction without overturning.

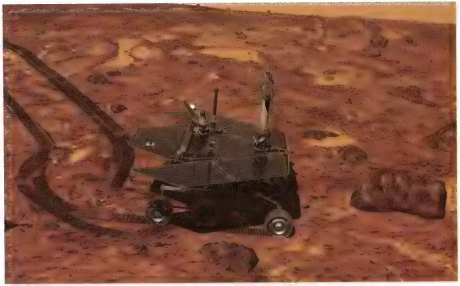
As a safety mechanism, however, the control software will avoid getting the vehicle into any position where the tilt exceeds 30°.

On flat ground the Rover has a maximum speed of 5cm per second. However, in order to avoid getting stuck, the control software causes the Rover to stop and assess its location every few seconds. This results in an average speed of around 1cm/sec or 36



The aeroshell protects the Rover from fiery temperatures as it enters the Martian atmosphere. The craft are scheduled to arrive in January 2004.

With the parachute deployed, three retrorockets fire their engines, suspending the lander 10-15m above the Martian surface. It then drops onto its own deployed airbags.



The Rover undergoing testing on a simulation of the Mars surface. The real mission is scheduled to run for 90 Martian days. Conversion factor: 1 Day_M = $24H_E$, $38M_E$ and $225S_E$, (about 92-and-a-bit D_E!) (NASA/JPL)

metres/hour. (It won't be able to escape any war-like Martians!)

Driving the Rover consumes around 100W. This is supplied by solar panels generating about 140W while they are illuminated for the four hours of each (Martian) day. For the rest of the time two rechargeable batteries provide power to the Rover.

The mission is scheduled to run for 90 Martian days, during which time the solar panels will become increasingly coated with dust. By the end of the mission, their generating capacity will be reduced to 50W.

This phenomenon was initially observed during the 1997 Pathfinder mission and is one of the factors which will ultimately end the mission.

The Rover Electronics Module (REM) processes information from the various sensors, power systems and communications links to control the Rover and send data back to Earth. The REM contains 128Mb of DRAM and 3Mb of EEPROM.

This does not sound like a great amount but specialised memory chips must be used to safeguard against data loss from the extreme radiation encountered in space, as well as the possibility of power outages.

To put it into context, these Rovers will have around 1000 times the memory capacity of the Rover aboard the Pathfinder mission.

A fair proportion of the computing power is dedicated to running the IMU, or Inertial Measurement Unit. This provides triaxial information on its position, allowing the Rover to make precise vertical, horizontal and yaw movements.

Another function of the Rover software is to perform constant system health checks, ensuring that the temperature is regulated and that the power systems are functioning, for example.

Communications systems

The Rovers employ a complex communications system to send data back to Earth. Direct communication to Earth, via either low gain (omni-directional) or high-gain (directional) antennas, is one option.

In addition, the Rovers can communicate directly with Mars-orbiting craft, such as 2001 Mars Odyssey and the Mars Global Surveyor satellites. These satellites can then relay information back to Earth.

Using a combination of these two techniques, the Rover can maximise possible transmission times (as the relative positions of Earth, Mars and the satellites will affect which is the suitable means of transmission).

The data rate between the Rover and Earth varies between 3,500 bits/second and 12,000bps, depending on various environmental factors. The data rate to the orbiting satellites, on the other hand, is 128,000bps, so this form of relayed communications is used wherever possible.

Visual systems

Rovers carry nine onboard cameras. Four are for hazard avoidance while two are used for navigation.

The four hazard-avoidance cameras are mounted on the bottom at the front and rear of the Rover. They operate, in black and white, to build a three dimensional map of the surrounding terrain extending 4m around the vehicle.

Onboard image processing software allows Rover to think for itself, in addition to commands issued to it from Earth, in order to provide an additional safeguard to avoid obstacles.

The two navigational cameras are mounted atop the Rover's mast, to provide a stereoscopic 45° view of the terrain in front of the cameras. These images are used to support navigational planning by scientists and engineers back on Earth. Motors within the mast assembly allow the cameras to rotate.

Head and neck

Giving the Rover its distinct appearance, the 1.4m Pancam Mast Assembly serves two functions. It acts as a periscope for the Mini-TES scientific instrument which must be housed within the Rover body for thermal reasons. Secondly, the mast provides a high vantage point for the cameras.

Built into the mast assembly is a motor which can turn the cameras and Mini-TES 360° in the horizontal plane. A second motor, responsible for elevation, can point the cameras 90° above and below the horizon. A third motor, dedicated to moving the mini-TES, can rotate this instrument from 30° above and 50° below the horizon.

Robotic arm

More than just another gadget to convey human-like characteristics, the Rover arm, also called the Instrument Deployment Device (IDD), manoeuvres the geological instruments for examining the Martian rocks and soils.

IDD has three joints, a wrist, elbow and shoulder joint. At the end of the arm is cross-shaped turret which rotates to whichever of the four scientific instruments is needed at the time.

When the Rover is moving on to its next destination, the arm is folded onto itself around the elbow and rests in the front of the Rover body, safe from harm.

When it is needed it simply extends, selects the appropriate tool and goes to work. The four instruments are as follows:

Rock abrasion tool (RAT)

The RAT is a powerful grinder weighing just 720g, able to create a hole 45mm in diameter and 5mm in depth into solid rock.

Three motors drive the abrasive grinding head. When a fresh rock surface is exposed by RAT, it can be examined by Rover's other scientific tools.

Microscopic imager (MI)

The MI is a combination of a microscope and a CCD camera (1024 x 1024 pixels) which will provide close-up views of the surface details of soils or rocks, especially rocks previously operated upon by the RAT.

Mossbauer spectrometer (MB)

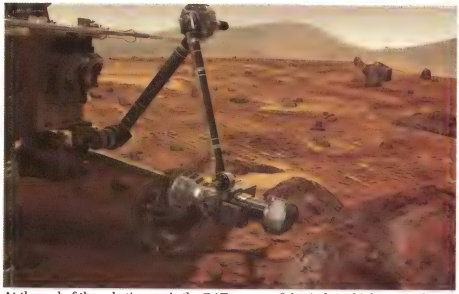
The MB is a spectrometer which is designed to provide the specific compositions of iron-rich minerals which predominate on Mars.

The measurement head of the MB resides on the end of the robotic arm, with the associated electronics taking shelter in the Rover's Warm Electronics Box (WEB – insulated using gold sheeting and very precisely temperature regulated).

To take a measurement, the sensor head is pressed against the rock or soil sample for a 12-hour period.

Alpha Particle X-Ray Spectrometer (APXS)

Another tool designed to determine the chemical composition of the surface of Mars, the APXS measures emitted alpha and X-ray particles from rock and soil samples.



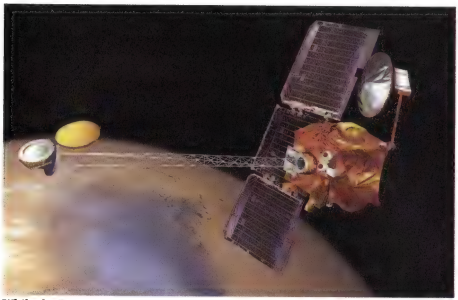
At the end of the robotic arm is the RAT, a powerful grinder which can make a hole 45mm in diameter, 5mm deep. The grindings can then be analysed using a range of on-board scientific equipment. (NASA/JPL)

Alpha rays are emitted by radioactive decay, indicating the presence of various isotopes. X-rays will be reflected, like light or microwaves, from the surface in amounts depending on composition.

Like the other instruments in the arm, the APXS electronics reside in the WEB. A single APXS measurement will take several hours at least, in order to gather enough useful data.

Mast instruments

In addition to these four instruments residing in the Rover's arm, there is other scientific apparatus in the Pancam Mast Assembly, as follows.



While the Rover can communicate directly with Earth, it will usually use the Odyssey spacecraft (in orbit around Mars) as a repeater, with data transmission rates to Earth up to 50 times faster compared to direct transmission. (NASA/JPL)

Miniature Spectrometer (Mini-TES)

The Mini-TES is a standard spectrographic device which is used to determine the composition of rocks and soils. It does this by analysing their patterns of reflected thermal radiation, which vary based upon the composition of the material.

A goal of the Mini-TES is to search for materials which owe their existence to a presence of water such as clays and carbonates.

The body of the Mini-TES is in the chassis of the Rover, where the mast meets the base. At the top of the mast is a periscope which moves around in various directions and focuses light down through the mast towards the Mini-TES apparatus.

Pancam

Mounted atop the mast, the Pancam is an ultra-high resolution CCD imaging system. Weighing just 270g, it can produce image mosaics with resolutions as high as 4000 pixels high and 24,000 pixels around. A filter wheel sitting in line with the Pancam lens provides imaging within various wavelength bands.

Seven months to go!

All told, when the Rovers arrive at Mars during January 2004, they are set to provide the most amazing insight into the planet to date. **SC**

Acknowledgement: Thanks to NASA and the Jet Propulsion Laboratory for the information and photographs used in this feature.

Motors, servos and steppers: A Chookhouse Door Controller

by Stan Swan

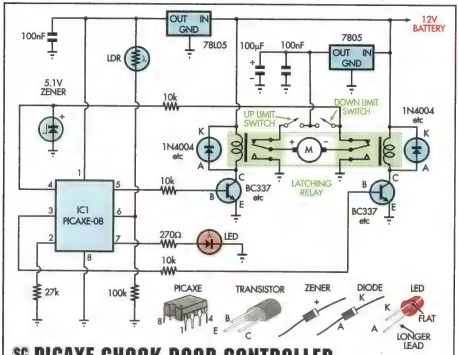
An "eggsotic" barnyard electronics project, just submitted by Simon Goldstone, a rural Queensland reader, uses an "08" to control his chookhouse door for automatic sunset and dawn operation. Naturally several interlock safety features have been added, so chooks are not beheaded ("picaxed" – maybe that's what it means ?!) or left on the wrong side of the motorised door. The score so far has the "hentertained" chooks now well ahead of the night-prowling foxes. . .

In May we introduced PICAXE control of a small 2-lead DC motor, using "08"-generated PWM to alter spin rate. Without such efficient digital power pulses, speed control would have been wasteful of supplied energy and could even lead to transistor or "pot"(variable resistor) burnout.

Although the "08" is obviously a budget microcontroller, often struggling with demanding applications that its big brothers "18A" and "28A" more easily tackle, its ability to handle such real world tasks justifies further motor punishment!

The "big kid" in most of us naturally means that one of the most entertaining aspects of electronic circuits relates to their control of moving devices. Many of us still maybe glance admiringly as remote control garage doors and the like "do their stuff", with even perhaps a nod to centuries of engineering developments that yielded such (now) commonplace devices. Engineering often evolves from ingenuity of course!

Thus it is with this month's application. Sick of having his chooks disappearing at the hand (mouth?) of some cunning foxes, our reader devised a way of fitting a motorised door to his henhouse which automatically closed the door at sunset and opened it up again at sunrise – times when the pesky foxes knew that



SC PICAXE CHOOK DOOR CONTROLLER

The circuit diagram of the chookhouse door controller. It's not meant to be a constructional project as such (though it will work!) but more of a source of ideas for you to experiment with. This circuit does not show the usual pin 7 program/run switch nor the pin 2 programming input.

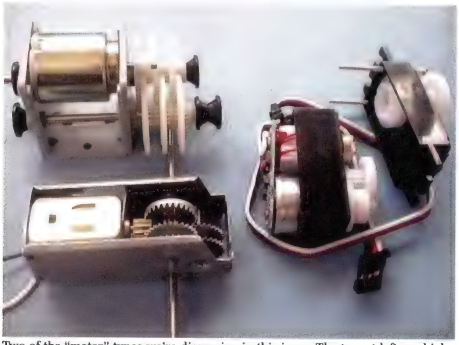
rule 0.22 might even things up.

We're not even going to try to describe the door mechanics – that's up to you, even though the photos overleaf show it in some detail – and you may care to add more code to do more things than our farmer did.

First, let's look at some of the types of "motors" you will come across.

1: Small DC motor types

We know how easy it is to drive a small DC motor with the PICAXE (circuit and code in last month's issue). Such a motor was used for the chookhouse door (see photos over page).



Two of the "motor" types we're discussing in this issue. The two at left are high-revving, low-voltage DC types, geared down to a usable speed (and to gain extra torque). At right is a disassembled radio-control servo. Note that it too contains a small DC motor inside, along with control circuitry.

Again, not so much a project as an example of a PICAXE application, this shot of the chookhouse door shows how the door is raised and lowered (gravity pulling it down).

However, typical 2-lead permanent magnet DC motors usually spin at such high speeds (~10,000 RPM) that direct coupling to their rotating shafts is difficult unless gearing is used.

Although hobbyist gear sets can give versatility and speeds down to only a few rpm at good torque, friction losses may be crippling unless using more costly units such as Tamiya.

Exact positioning needs may be tricky but could use sensors such as LDRs (which can be influenced by stray light/dirt/insects), magnets (activating reed switches or Hall Effect devices), mechanically operated switches, ultrasonics, resistive or even capacitive proximity changes. The choice often relates to reliability.

Spin direction control, however, can be as simple as swapping over supply lead polarity, perhaps via DPDT (Double Pole Double Throw) switches and relays. H bridges (named for their "stretched out" rectifier bridge style design, with a motor at the H crossbar) simplify control but cheap motor driver ICs such as the Unitrode L293D streamline even this – as used on the Rev. Ed AXE023 controller board.

As they rotate, normal brush and

BASIC PROGRAM LISTING

(This can also be downloaded from http://picaxe.orcon.net.nz/chookfox.bas)

```
  start:
pins = 0                  'reset outputs to low
readadc 1 ,b0             'read ldr on pin 1
if b0 >= 43 then raise    'this value is to kick start the system after
                          'initial powerup (ie after battery charging)
if b0 < 43 then lower     'as above
  raise:                  'this routine raises the door
low 4                     'make sure the lowering output pin 4 is kept low
high 2                    'send up command from pin 2 to latching relay via up transistor
pause 500                 'hold high for .5 seconds
low 2                     'send pin 2 low. Relay will have latched.
goto up                   'once door has been commanded to raise move on
                          'monitoring routine of opened door
  up:                     'monitors open door and waits for pre close command
readadc 1 ,b0
if b0 < 64 then lower     '64 is the value of the door closing command
if b0 <= 107 then pre     'this value is included to give a visual warning
                          'via the LED on output 0 that door closure is approaching.
high 0                    'this is a monitor function to indicate the system is active
pause 500
low 0
wait 30
goto up
  lower:                  'this routine lowers the door
low 2                     'ensures the raise output is kept low
high 4                    'send down command from pin 4
pause 500                 'hold pin 4 high for .5 seconds
low 4                     'return pin 4 low. relay will have latched
goto down
  down:                   'this routine monitors the door once it is down
readadc 1 ,b0
if b0 > 107 then raise    'commands raise routine when enough light available
if pin3 = 1 then warn     'pin 3 monitors the down microswitch. A visual
                          'output on pin 0 alerts that door is not closedwhen dark
if pin3 = 0 then rest     'this line added to avoid recurring problems with
                          'false triggering during darkness
goto down
  warn:                   'this routine is the warning output from pin 0
for b1 = 1 to 20          'sets no. of flashes of LED
high 0
pause 20                  'keep pin 0 high for .02 seconds
low 0
pause 500                 'keep pin 0 low for .5 seconds
next b1
pause 500                 'wait .5 seconds
goto down
  pre:                    'this routine added to give a visual aid so one can see that the
                          'system is armed for closing just before dark.Very useful
high 0
pause 20                  'keep pin 0 high for 20 milliseconds
low 0
pause 100                 'keep pin 0 low for .1 seconds
high 0
pause 20
low 0
wait 10                   'wait 10 seconds
goto up
  rest:                   'the rest sequence to conserve power but mainly to stop
                          'false triggering during darkness which can cause the
                          'door to get spurious up commands
sleep 300
goto down
```

commutator DC motors often generate *appalling* electrical noise which needs filtering via capacitors across the motor terminals. Without this a PICAXE may be so confused with the "hash" that it ceases responding.

Separate power supplies, needed of course on more powerful systems drawing many amps, help reduce hash too.

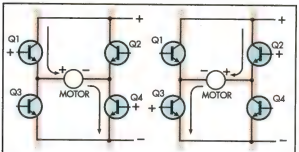
2: 3-lead RC servos

RC stands for Remote or Radio Control. Servos are very commonly used for radio controlled model aircraft and boats still contain a small DC motor.

But they also have a precision gearbox, control electronics and a variable resistance (potentiometer) inside. The pot acts as a feedback device for the internal circuitry to inform of external shaft rotation angle before it "holds".

Control is by a single wire pulse width – an easy task for a PICAXE. Just as easy is the code to achieve the right pulse width.

By convention, 1.5ms-wide pulses (1500µs), with 20ms pauses between, set the servo shaft to its centre, or



H-bridge circuit operation. It looks somewhat like a "bridge" rectifier with the DC motor across the junction (of transistors in this case). The motor can be run in either direction by turning on the appropriate pairs of transistors. Turning on Q1 and Q4 makes motor current flow from +ve to -ve, rotating the motor one way, while turning on Q2 and Q3 reverses the motor current flow, also reversing the rotation.

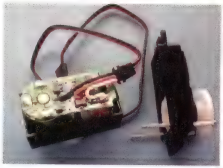
neutral, position. We use both those terms, pulse and pause, deliberately, for reasons you'll see shortly.

Pulse width variations down to 1ms turn the servo shaft in the left direction (the exact position depending on the exact pulse widths). Similarly, pulse widths between 1.5ms and 2ms turn the shaft in the right direction.

In the absence of any further change of pulse width, the servo holds position with good torque – the action (and sound!) is akin to aircraft flaps being extended.

"Pulsout" and "Pause"

The PICAXE's "pulsout" command can give us the exact pulse length required – remember (from our March foray into PICAXE ADC) that they can be timed to microseconds – and the pause command can give us the required spacing between the pulses. Aha! Pulse and Pause – where have we heard that before?

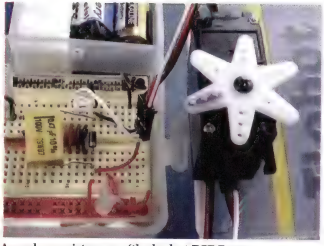


Another view inside a servo, this time from the underside. You can just see some of the control electronics under the PC board.

Connecting a servo

Simply connect the servo's white control wire straight to the PICAXE-08's output 2. The red (+) and black servo power leads, conveniently 4.8V at modest currents, need the usual back-

Driving servos and steppers with the PICAXE-08



A garden-variety servo (the budget DSE P-9061 – apparently generic with Futaba/Hitec, etc servos) connected to the PICNIK box for testing. The servo white (data) wire connects directly to the PICAXE I/O channel 2 (pin 5) while (red and black) power connects to the 5V lines. Note the capacitor and diode across the servo power. Here's some PICAXE code to try it out:

```
loop:
for b1= 1 to 30: pulsout 2,100: pause 20: next b1: wait 1 ' 1mS
pulses = L
for b1= 1 to 30: pulsout 2,150: pause 20: next b1: wait 1 ' 1.5mS
pulses =Neutral
for b1= 1 to 30 :pulsout 2,200 :pause 20 : next b1: wait 1 ' 2mS
pulses = R
goto loop
```

Testing a stepper here is remarkably similar to our earlier solar motor set up (last month's issue) but with duplicated 4.7kΩ and BC547s on I/O output 1 (IC pin 6) to give two active output pins. The PICAXE-08, which is only able to source (supply) ~20mA at each output, has insufficient stepper drive capability alone of course. Here's the testing code ...

```
'code snippet to exercise Jaycar YM2752 Bipolar 4 wire Stepper
with PICAXE-08
'motor just "rocks" since H-bridge or translator IC etc needed for
full spin
'Runs OK on 4.5V although stepper rated 7.5V 250mA. Use small
signal BC547
'Alter pulse periods and pause durations for different effects. Ref.
article & pix too

stepdemo:
for b0 = 0 to 10                    ' pulse loop
pulsout 1,5000:pause 500            ' Pin 1 5000 microsec pulse (= 5mS)
pause 20                            ' Brief pause 20mS
pulsout 2,5000:pause 500            ' Pin 2 5000 microsec pulse (= 5mS)
pause 20                            ' Brief pause 20mS
next b0                             ' repeat until completed
```

References and parts suppliers . . .

1. **"Practical Electronics for Inventors"** Paul Scherz – McGraw-Hill 2000 (DSE B1636). Much in the "Robot Builders Bonanza" style, but with superb general electronics insights and exquisite line drawings.

2. **"Easy Step'n – An Introduction to Stepper Motors"** David Benson – Square1Electronics **www.stepper-stuff.com** (Jaycar BS1504). Costly but perhaps the definitive work.

3. Jaycar – 3 Volt gear and hobby motor sets (YG2730 etc), 12V DC latching relay (SY4060), limit switches (SM1308), LDR (RD3480), plus low power 4- wire stepper (YM2752 ~$15)

4. Dick Smith – general purpose RC Servo (P9061 ~$20), 3 Volt Tamiya motorised gear sets (P9057 or P9051 ~$15) and sundry parts.

5. **www.cs.pitt.edu/FORTS/jim/stepmtr.htm** – stepper motor animations!!

6. **www.doc.ic.ac.uk/~ih/doc/stepper/** – links detailing PC disk drive steppers

7. **www.nutsvolts.com** – Bulletin Board for US "Nuts & Volts" monthly mag.

8. **www.picaxe.co.uk** Revolution Education – Forum pages especially

9. **www.picaxe.com.au** or **www.microzed.com.au** – MicroZed (official Australian agents)

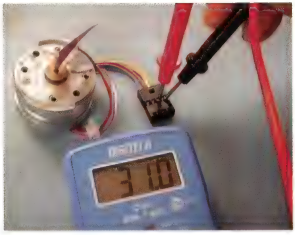
10: **www.technologicalarts.com/myfiles/data/L297D.pdf** – L297D data sheets

11: **www.picaxe.orcon.net.nz** – author's enthusiastic web site with many links.

EMF diode and good sized (220nF?) hash-taming capacitor across them. For "getting your feet wet" with PICAXE-controlled motors, these servos look near ideal. Recommended!

3: Stepper Motors

Stepper Motors, although today's electronic workhorses, contrast with servos in their demanding ***external*** drive circuitry – they're certainly not



It's quite easy to work out the various coil connections in a stepper motor because they are all isolated from each other. A fairly low resistance indicates a coil. Working out the start and finish of each coil is a little more difficult – the easiest way is to pulse each coil in turn and note the way the shaft turns. From this you can work out coil polarity.

WYSIWYG. You've only got to look at the "simple" stepper on Fisher and Paykel "smart washers", then check their attached swag of drive electronics to see this!

Steppers are digitally-controlled brushless motors (you can feel them "cog" when spun with your fingers) that rotate a small "step"(often 7.5°) as each clock pulse is applied via external circuitry.

There are ***many*** types, with 8, 6, 5, or 4 leads – universal, unipolar and bipolar – the latter 4-wire types being cheapest but trickiest to drive.

A good source of stepper motors for hobbyist experimentation is ***old*** PC disk drives. (Modern drives tend to use voice coil actuation, not steppers).

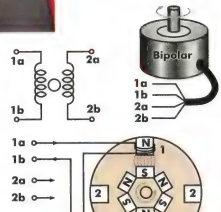
All steppers tend to be power hungry and often run off higher voltages (eg, 12V on PC disk drive types), so straight control from a 4.5V PICNIK box looks dicey. However, there are 5V steppers available.

They have no internal electronics – just coil pairs – so identification of the coils with a multimeter on Ohms is relatively easy when working out where all the wires go!

Controller ICs abound – especially the Allegro UCN5804 Stepper Motor Translator and SGS-Thompson's L297D Bipolar Translator. These greatly reduce the cost, bulk and inconvenience of discrete devices.

For a PICAXE insight however, near direct connection with a cheap bipolar model (Jaycar YM2752 – actually a Berger Lahr RDM37/6G = **R**eversible **D**igital **M**otor **37**mm diam/**6**-pole) proved possible.

The unit is only "exercised" here and doesn't spin, since pole pairs need alternating supply voltages and polarities for rotation.



This diagram of a bipolar stepper (after "Practical Electronics for Inventors" [Scherz]) illustrates how the windings are connected together to achieve rotation. It is up to the drive circuitry to energise the coils at the right moment.

If you're determined to spin those wheels with this budget low power unit, it's suggested the cheap, specialised driver ICs be used, although I'll be delighted to hear of any "straight 8" workarounds!

And don't forget to feed those chooks!

Hey, maybe a PICAXE-controlled chook feader could be next . . . **SC**

NEXT MONTH:

PICAXE data communications (with a new use for damp string!)

These '08's can also reach out,
With datacomms part of their clout.
They'll even "swap notes",
*Almost ANN (*refer quotes),*
To yield more applications – no doubt!

PICAXE Telephone Intercom/Interface

Here's a very commonly requested circuit: something to link two telephones together so they actually work! It works with just about any modern (ie, touchtone-type) phone – and will even work with cordless phones or a combination of cordless/corded models.

Design by David Lincoln

Somehow, just about every hobbyist has managed to score a phone or two for his/her junk box. None of them are ex-rental, of course – they have just somehow materialised. But wouldn't it be nice if you could actually ***do*** something with them – like make them talk to each other?

Here's a simple circuit which does exactly that. It's based on our new best friend, the PICAXE-08, which means it is dirt cheap and easy to build. When either phone is picked up, the other one will ring until it is answered or the other phone is hung up.

And the really good news is that your calls don't cost you a cent.

Whether you build this as a toy for kids (that's what the circuit was originally designed for), as an intercom between rooms or even buildings of your home, business, factory, whatever; serious or flippant . . . this will do it.

Its range will depend to some degree on the cabling you use but could easily be a couple of hundred metres or so. And as we said before, you can even use cordless phones (or one of each) and make a fully wireless intercom.

Incidentally, phones make really great intercoms in noisy areas because the earpiece is so close to the ear – and you can yell into the mouthpiece to get the message across!

Connecting two phones

Unfortunately it's not simply a matter of plugging one phone into t'other and expecting them to work. Phones rely on signals, voltages, etc from the telephone exchange – so all we have to do is simulate the phone exchange, right?

That's pretty much how this circuit works. And we don't need a big building full of electronics! Fig.1 shows a block diagram of what is required.

A line interface does exactly what its name suggests: interfaces each phone to the line. That means we need two of them. We also need a transmission bridge, which connects the speech signals together. A controller determines when one phone is taken "off hook" (ie, the receiver is lifted) and so rings the other phone. Finally, a power supply provides all the voltages necessary to make the whole thing work.

Fig.2 shows the circuit diagram, again broken up into its functional blocks. First of all, we will look at one of the line interfaces. These may look a little complicated at first but they are really quite simple.

It works like this: when relay RLY1 is at rest (normally closed), power is supplied to the line via the two 330Ω

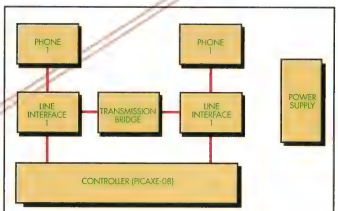


Fig.1: the Telephone Intercom in block diagram. You can compare these blocks to the circuits in Figs.2 & 3.

resistors. With a supply of around 30V, this means line current will be around 35mA (depending on the line resistance and type of phone).

When RL1 pulls in, the normally open contacts close and "ring current" flows in the phone line, causing the phone to ring.

What causes RL1 to pull in? The circuit detects an "off hook" condition by measuring the voltage across R2 (a 330Ω resistor). Zero volts across R2 means there is no current flowing, therefore the other phone is on-hook. When the phone is off-hook there will be up to 12V across R2 (again, depending on the line resistance and type of phone).

The circuit around the base of Q1 performs the off-hook detection. R4, R5 and R6 form a voltage divider network across R2. Their combined resistance is high enough to have no effect on the line current. C1, in conjunction with R4 and R5, filters out any AC components which may be present in the line current.

The lower half of the voltage divider, R5 and R6, turn Q1 on and off. When line current flows, the voltage at their junction is high enough to fully turn Q1 on. The voltage at Q1's collector is compatible with TTL levels and is fed directly into the PICAXE, which is programmed to detect this as "off-hook".

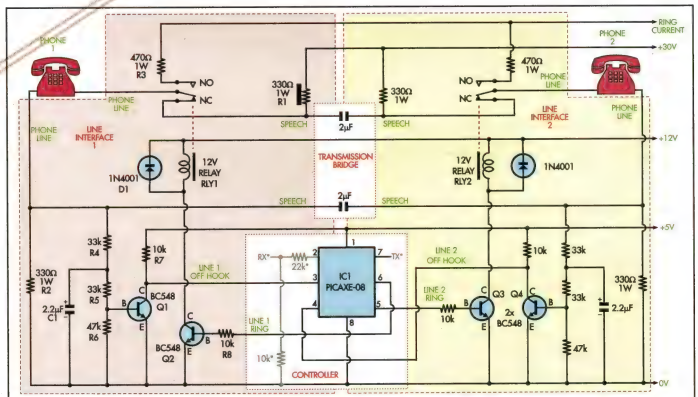
Q2 and its associated 10kΩ base resistor (R8) form a circuit which will operate RLY1 when there is a TTL-level signal at the "ring" terminal of the line interface. Obviously, this signal also comes from the PICAXE.

D1 protects the transistor from the back-EMF generated when RLY1 releases.

The speech signal appears directly across the speech terminals of the line interface and is connected to the other line interface via the transmission bridge (two 2µF capacitors). These capacitors block DC while allowing the speech signal (AC) to pass. Some of the speech signal will be lost due to R2 and R3. In a simple circuit such as this, with reasonably short distances between phones, there should be no problem, with enough speech signal left over to "drive" the other phone.

The controller

The PICAXE-08 microcontroller is programmed to read the the status of the off-hook signals from each phone and



SC PICAXE TELEPHONE INTERFACE

Fig.2: everything except the power supply. The two line interfaces are identical; the green labels are explained in the text. Components/connections marked * are only required while programming the PICAXE-08.

Parts List - PICAXE Telephone Intercom/Interface

Interface Unit

Semiconductors

1	PICAXE-08, programmed	(IC1)
4	BC548 NPN transistors	(Q1,Q2)
4	1N4001 1A power diodes	(D1, D2)

Resistors (0.5W, 1%)

2	47kΩ	4	33kΩ	1	22kΩ	3	10kΩ
2	470Ω 1W			4	330Ω 1W		

Capacitors

2 2.2µF electrolytic (C1)
2 2µF non-polarised

Miscellaneous

2 12V relays, SPDT contacts (RLY1, RLY2)

* Components of second (identical) interface not numbered on circuit diagram

Power Supply

Semiconductors

1	BD139 NPN power transistor	(Q1)
1	7812 12V positive regulator	(REG1)
1	7805 5V positive regulator	(REG2)
2	1N4001 1A diodes	(D1, D2)

Capacitors

1	470µF 35V electrolytic	(C1)
1	1000µF 35V electrolytic	(C2)
1	1000µF 50V electrolytic	(C3)
1	100µF 50V electrolytic	(C4)
4	100nF monolithic	(C5-8)

Resistors

1 1kΩ

Miscellaneous

1 240V to 30V, 20-30VA transformer
1 12V AC 1A plugpack

then use logic to provide ring signals to the phones.

We are not going to re-invent wheels by telling you how to program your PICAXE-08; that's the purpose of Stan Swan's "Fun With PICAXE" series which has been running in SILICON CHIP since February of this year.

Suffice to say that the 10kΩ and 22kΩ resistors are only required while programming (in fact, they may well be part of your programming setup) and can be removed once programming is accomplished. We imagine that anyone building this project will program the PICAXE out of circuit.

Software for the PICAXE is pretty straightforward – it is shown in a separate panel.

The power supply

The power supply circuit is shown separately in Fig.3. It supplies ring current, around 30V DC, 12V DC and 5V DC.

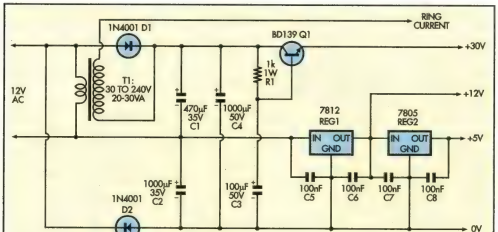


Fig.3: the power supply provides three DC outputs as well as the ring current. It is designed to operate from a 12V AC plugpack (12V DC will not work!). Transformer T1 is a small 240V:30V model used backwards.

The output from a 12V AC plugpack is rectified by a voltage doubler circuit consisting of the two 1N4001 diodes, C1, C2 and C3. This produces around 32V (give or take, depending on the regulation of your plugpack) across C3, the main reservoir capacitor. This capacitor also provides a low impedance return path for the ring current.

Half of the power supply output feeds a 12V regulator (REG1) then a 5V regulator (REG2) to give the +12V and +5V rails required by the line interfaces and controller. The 100nF capacitors around the regulators should be monolithic type; they bypass the supply lines to help prevent parasitic oscillations in the regulators.

Q1 and its associated components form an active filter for the 30V supply. Any ripple across C3 would be heard as a very annoying hum in the phone earpieces and the filter reduces that hum to inaudible levels.

The ring current is supplied by a 240V to 30V mains transformer connected backwards. This transformer needs to be rated at between 20 and 30VA. With a 12V input on the 30V winding, the output will be about 100V – enough to give you a nasty bite. So keep your fingers away from the ring current circuitry! The voltage will of course drop under load.

Construction

No PC board is provided for this project, the original being lashed together. Some readers may like to go the trouble of designing a PC board – it would make for a neater project.

Regardless of which physical method is used, construc-

tion proceeds as would any project – smallest components first, polarised components, semiconductors then "hardware". Don't mount the PICAXE-08 yet – however, an IC socket is a good idea.

Resistors R1 and R2 can get hot, so they should be mounted a few millimetres above any board to allow air circulation.

It is NOT a good idea to use standard phone sockets or jacks for this project. Obviously it cannot be connected to the public phone network (not only will it not work, it's illegal!) so to avoid the possibility of someone doing this by mistake, we suggest some other form of 2-pin plug and socket to connect this circuit to your phone lines.

You will of course need a standard (modular-type) plug to connect to the majority of phones.

Testing

Ensure there are neither phones nor microcontroller plugged in. Apply power from the 12V AC plugpack (note that it must be AC, not DC) and measure the voltages out from your power supply. The main DC supply should be around 30-32V or so – the exact value is not critical and will vary a little depending on the mains voltage and the quality of your plugpack.

The 12V and 5V supplies should be pretty-well spot on, as they are coming from regulators.

Using an AC range on your multimeter, measure the ring voltage (the output from the transformer). It should be about 100V (and remember, it can bite a bit!).

If all voltages are OK, disconnect power and wait until the capacitors have discharged. Plug in the PICAXE (assuming you have programmed it already!) and both phones. Reconnect power.

When you lift one phone the other phone should ring. When it does, pick it up and verify that the ring stops. If the ring continues, it will be heard as a very loud buzzing noise in the earpiece (don't put it against your ear as it could be quite painful!).

If all is well and the ring has stopped, check that you can talk into one phone and be heard in the other.

Duplicate the testing for the other phone. If all checks out, well done!

Aw shucks! It doesn't work!

If the power supply voltages are not as they should be, check your wiring and component placement. There is very little else that could be wrong with the power supply.

If a phone doesn't ring, first check both line circuits. Use a multimeter to check the voltage between the phone terminals with the phone disconnected – it should be nearly the same as the DC output of the power supply. If that's OK, measure the voltage across R2 with the phone on-hook and off-hook. It should be zero on-hook and around 6-12V off-hook.

Repeat the voltage checks, on-hook and off-hook, at the collector of Q1. This time it should be about 5V and less than 0.5V respectively.

To test the ring, disconnect power and wait for the capacitors to discharge. Remove the microcontroller, then reconnect power with both phones connected. Using a jumper lead, temporarily connect the ring terminal for each line to +5V.

Verify that the relay operates and the phone rings.

Telephone Intercom - PICAX-08 Code

```
main:
    let b0 = 0
loop:
    if pin4 = 1 and pin3 = 1 then atrest
    if pin4 = 1 and pin3 = 0 and b0 = 0 then
ring1
    if pin4 = 0 and pin3 = 1 and b0 = 0 then
ring2
    if pin4 = 0 and pin3 = 0 then clearing
    goto loop
atrest:
    low 1
    low 2
    let b0 = 0
    goto loop
ring1:
    high 1
    goto loop
ring2:
    high 2
    goto loop
clearing:
    low 1
    low 2
    let b0 = 1
    goto loop
```

If all else fails, try substituting another phone or two (use phones that are known to be working). Note that older phones equipped with mechanical bells may not work properly with this circuit.

Your phone lines

Note our comments before about NOT connecting this system to the public phone system.

Because it is a fully private system, you can use virtually any 2-wire cable between the phones.

Phone wire is an obvious choice but you could use speaker wire, bell wire, even two strands of fence wire if they are on insulated posts! (Well, at least when the posts are dry!).

And if you're in the bush its probably a good idea to keep your phone wiring well away from any electric fence wiring !

The circuit should work with lines up to several hundred metres in length (depending on the type of wire used and most particularly the resistance). In fact, the line resistance will be the main factor in determining distance.

Standard 0.5mm phone wire should be OK up to say a couple of hundred metres; longer runs may need thicker wire.

And while there are regulations which don't allow you to connect this to the mate's place next door (ie, over the boundaries of your property), we could never condone your breaking those rules . . .

SC

PICAXE-08 Port Expansion

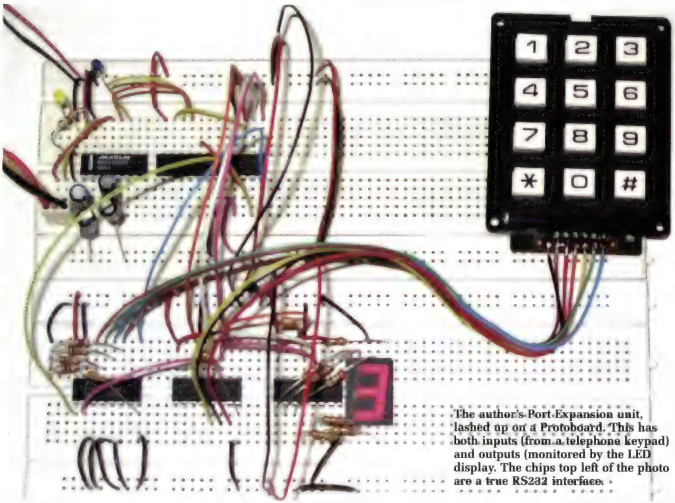
Everyone is raving about the PICAXE-08. It's tiny, cheap and is so easy to program that even beginners can do it. There is one major drawback, though: it only has five pins available for input and output ports. Not any more, it ain't!

by David Lincoln

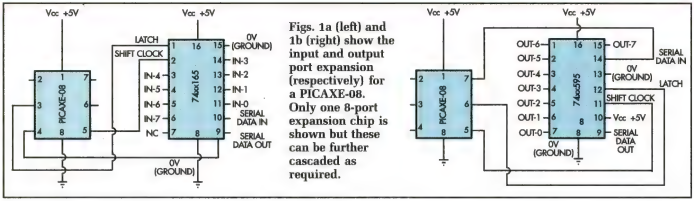
Sure we could use the PICAXE-18 or PICAXE-28 when we need more inputs and outputs (both of which have significantly more i/o pins) but that would defeat the purpose of using a small, low-cost chip.

Fortunately there is a simple solution. By using 74xx165 and the 74xx595 shift registers, we can expand the number of input and output ports in multiples of eight.

Fig.1 shows how. In Fig.1a a 74xx165 is being used to expand the number of inputs to eight. This requires three of the PICAXE ports; one for serial data, one for clocking



The author's Port Expansion unit, lashed up on a Protoboard. This has both inputs (from a telephone keypad) and outputs (monitored by the LED display. The chips top left of the photo are a true RS232 interface.



Figs. 1a (left) and 1b (right) show the input and output port expansion (respectively) for a PICAXE-08. Only one 8-port expansion chip is shown but these can be further cascaded as required.

the shift register, and one for latching the data into the shift register.

The 74xx165 also has a serial output port making it possible to daisy chain multiple 165's to achieve even more inputs.

To read 8 input lines from a single 74xx165 the PICAXE-08 code is: -

```
Symbol      latchin = 4
Symbol      datain  = pin3
Symbol      clk     = 2

Main:
   High latchin
Loop:
   Gosub bytein          'Read a byte into b1
   Goto loop             'Loop forever

Bytein:                  'Reads a byte of data into b1
   Pulsout latchin, 1    'Latch the input register
   Let b1 = 0            'Initialise data to zero
   For b0 = 0 to 7       'Count to 8
   Let b1 = b1 * 2       'Shift left
   If datain = 0 then nobit  'Test for a data bit
   Let b1 = b1 + 1
Nobit:
   Pulsout clk, 1        'Clock the shift register
   Next b0
   return
```

In Fig.1b a 74xx595 is being used to expand the number of outputs to eight. Once again three PICAXE ports are needed; one for serial data, one for clocking the shift register, and one for latching the data. Like the 74xx165, the 74xx595 also has a serial output port, again making it possible to daisy chain multiple 595's to achieve even more outputs.

Fig.2 combines both of the above circuits into one, giving both input and output port expansion for the '08.

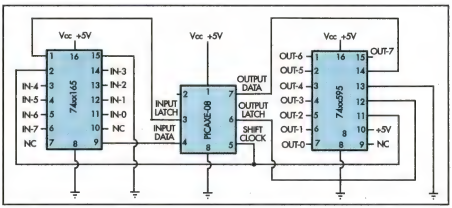
To output 8 bits from a single 74xx595 the PICAXE-08 code is: -

```
Symbol      dataout  = 0
Symbol      clk      = 2
Symbol      latchout = 1

Main:
   For b3 = 0 to 255        'Output the numbers 0 thru 255
   Let b2 = b3
   Gosub byteout
   Next b3
   Goto main                'Loop forever

Byteout:                    'Output the byte in b2 — b2 is
                             destroyed in the process
   For b0 = 0 to 7          'Count to 8
   Let b1 = b2 & 1          'Mask off low order bit
   If b1 = 1 then outhi     Test for output bit
   Low dataout              'Set output bit to zero
   Goto clockout
Outhi:
   High dataout             'Set output bit to one
Clockout:
   Pulsout clk, 1           'Clock the shift register
   Let b2 = b2 / 2          'Shift right
   Next b0
   Pulsout latchout, 1      'Latch the output register
   return
```

Expanding both the input and output ports at the same



time can be achieved by combining the circuits of Figs.1a and 1b into the circuit of Fig.2. Only five PICAXE ports are required because the clock line can be shared by the input and output shift registers. That's just as well, because the PICAXE-08 has more than four and less than six ports . . .

Now that we have eight inputs and eight outputs to play with we can run some experiments. By connecting push button switches to the expanded input ports and LEDs to the expanded output ports, we can show that our port expansion unit is working. Fig.3 shows what's needed.

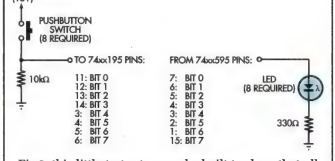


Fig.3: this little test setup can be built to show that all is working properly.

To copy 8 bits from input to output, the PICAXE-08 code is: -

```
Symbol      latchin = 4
Symbol      datain  = pin3
Symbol      clk     = 2
Symbol      dataout = 0
Symbol      latchout = 1

Main:                       'Read a byte into b1 and output it
                            from b2
    High latchin
Loop:
    Gosub bytein            'Read a byte
    Let b2 = b1             'Copy input to output
    Gosub byteout           'Write a byte
    Goto loop               'Loop forever

Bytein:                     'Reads a byte of data into b1
    Pulsout latchin, 1      'Latch the input register
    Let b1 = 0              'Initialise data to zero
    For b0 = 0 to 7         'Count to 8
    Let b1 = b1 * 2         'Shift left
    If datain = 0 then nobit    'Test for a data bit
    Let b1 = b1 + 1
Nobit:
      Pulsout clk, 1        'Clock the shift register
      Next b0
    return

Byteout:                    'Output the byte in b2 — b2 is
                            destroyed in the process
    For b0 = 0 to 7         'Count to 8
    Let b1 = b2 & 1         'Mask off low order bit
    If b1 = 1 then outhi    'Test for output bit
    Low dataout             'Set output bit to zero
    Goto clockout
Outhi:
    High dataout            'Set output bit to one
Clockout:
      Pulsout clk, 1        'Clock the shift register
      Let b2 = b2 / 2       'Shift right
      Next b0
    Pulsout latchout, 1     'Latch the output register
    return
```

Almost anything that recognises or runs from a TTL-compatible signal can be connected to the expanded input and output terminals. Fig.4 shows how to connect a 7-segment LED display and Fig.5 shows how to connect a telephone pushbutton keypad.

Here is the PICAXE code to display the numbers 0 through 9 on the 7 segment display: -

```
Symbol      dataout = 0
Symbol      clk     = 2
Symbol      latchout = 1

Main:                       'Output the numbers 0 thru 9 on
                            a 7 segment display
    For b3 = 0 to 9
      Lookup b3, ($BE, $82, $DC, $D6, $E2, $76, $7E, $92,
$FE, $F2), b2
      Gosub byteout
      Pause 500
    Next b3
    Goto main               'Loop forever

Byteout:                    'Output the byte in b2 — b2 is
                            destroyed in the process
    For b0 = 0 to 7         'Count to 8
      Let b1 = b2 & 1       'Mask off low order bit
      If b1 = 1 then outhi  'Test low order bit
      Low dataout           'Set output bit to zero
      Goto clockout
Outhi:
      High dataout          'Set output bit to one
Clockout:
      Pulsout clk, 1        'Clock the shift register
        Let b2 = b2 / 2     'Shift right
      Next b0
      Pulsout latchout, 1   'Latch the output register
    return
```

The following code will read the buttons pressed on a telephone keypad and display the result on the LED display. To do this we need 10 output lines, more than can be achieved with a single 74xx595, so a second '595 is daisy chained to the first to give 8 extra outputs (see Fig.5). A similar technique could be used to daisy chain '195 shift registers to give more inputs.

```
'Keypad input - 7 seg. display output
'
'       b0      bit counter
'       b1      temp work data
'       b2      display data
'       w4      output data
```

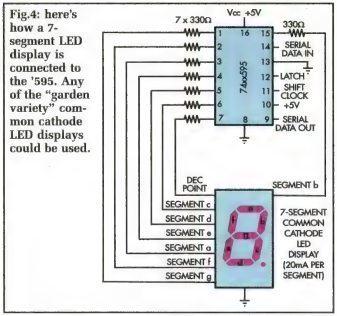


Fig.4: here's how a 7-segment LED display is connected to the '595. Any of the "garden variety" common cathode LED displays could be used.

```
'
'Digit          0  1  2  3  4  5  6  7  8  9  *  #
'Segment code $BE, $82, $DC, $D6, $E2, $76, $7E, $92,
$FE, $F2, $68, $EB
'
'b2 bit         7 6 5 4 3 2 1 0
'Segment        b g f a e d c dp
'
symbol          clk = 2
symbol          latchout = 1
symbol          dataout = 0
symbol          datain = pin3
symbol          latchin = 4

main:
        high latchin
loop:
        let w4 = b2 + $100
        gosub inout
        lookup b1, (b2, $82, $E2, 0, $92, 0, 0, 0, $68), b2
        if b1 <> 0 then loop
        let w4 = b2 + $200
        gosub inout
        lookup b1, (b2, $DC, $76, 0, $FE, 0, 0, 0, $BE), b2
        if b1 <> 0 then loop
        let w4 = b2 + $400
        gosub inout
        lookup b1, (b2, $D6, $7E, 0, $F2, 0, 0, 0, $EB), b2
        goto loop

inout:
wordout:                'Output the word in w4 - destroys w4
        for b0 = 0 to 15
          let b1 = w4 & 1
          if b1 = 1 then outhi
          low dataout
          goto clockout
outhi:
          high dataout
clockout:
          pulsout clk, 1
          let w4 = w4 / 2
          next b0
        pulsout latchout, 1

bytein:                 'Read a byte into b1
        pulsout latchin, 1
        let b1 = 0
        for b0 = 0 to 7
          let b1 = b1 * 2
          if pin3 = 0 then nobit
          let b1 = b1 + 1
nobit:
          pulsout clk, 1
        next b0
        return
```

SC

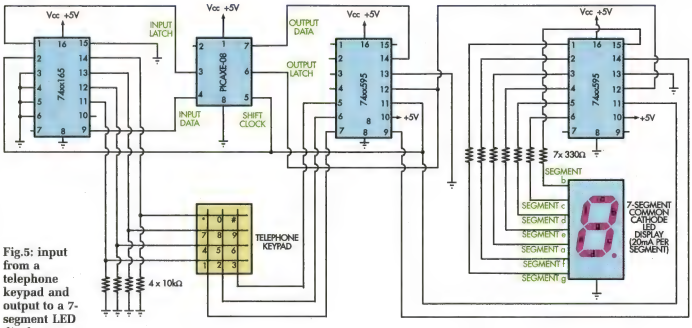


Fig.5: input from a telephone keypad and output to a 7-segment LED display.

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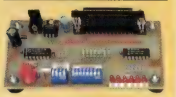

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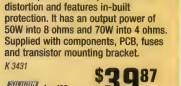

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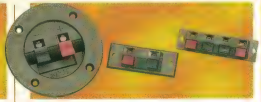

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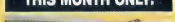

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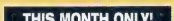

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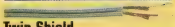

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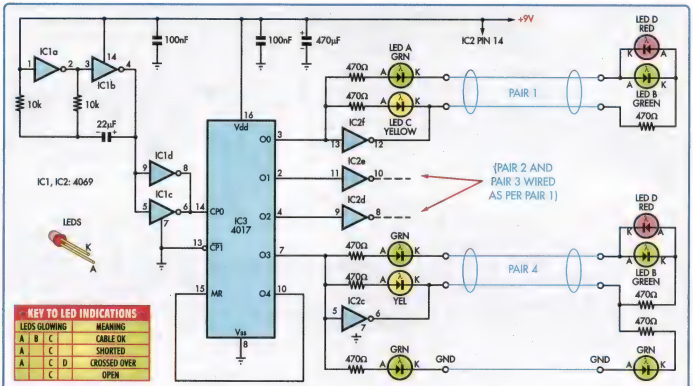


Computer data cable tester

You don't need access to fancy test gear to check and fault-find computer data cables. Instead, this simple device will give a quick indication of the status of point-to-point cable wiring; ie, crossovers, shorts and open circuits.

It works like this: IC1a & IC1b (part of a 4069 hex inverter IC) form an oscillator which provides a 1Hz clock signal. Its output is buffered and inverted by IC1c and IC1d (connected in parallel) and clocks IC3, a 4017 decade counter.

IC3's O4 output is connected back to its reset pin (pin 15). As a result, IC3 toggles its O0 - O4 outputs high (and low) in sequence to test the four data pairs and the ground (GND) connection (if required).

In operation, IC3's outputs drive the indicator LEDs and inverters IC2c-IC2f. Note that there are four indicator LEDs for each pair. LEDs A & C connect to the local end of the cable, while LEDs B & D connect to the remote end.

The inverted outputs provide the return paths for the relevant "mate" of each tested pair. As a result, if the cable is OK, LEDs A, B & C will all light for each tested pair.

The "D" LEDs at the remote end indicate if there is a crossover in the cable, while the "C" LEDs indicate which pair is being tested. As well, two extra LEDs are connected in series with the GND lead (one at either end) to indicate its status. These LEDs are driven by the O3 output of IC3 via 470Ω resistors.

Finally, note that the LEDs must be high-brightness types.

A Liehr,
Kallangur, Qld. ($50)

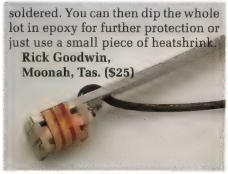
Inductive speed sensor for cars

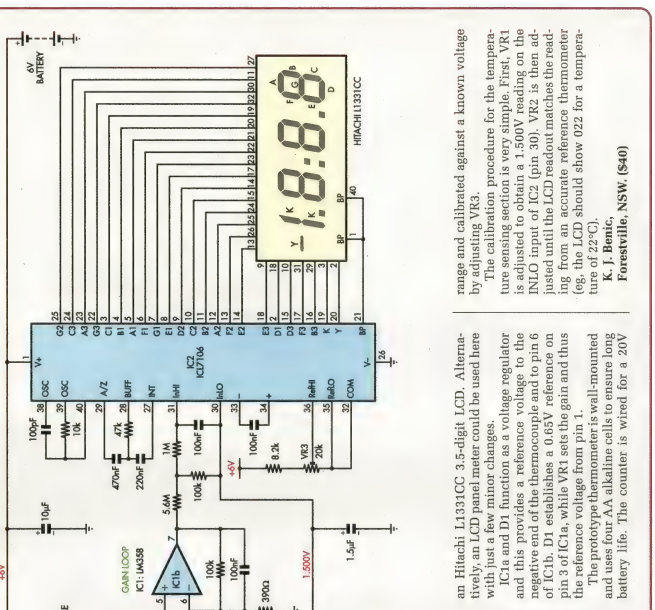
Here's a way to avoid winding the pickup coil for the inductive speed sensor used in projects such as the Speed Alarm, Gearshift Indicator, etc.

All you need to do is carefully break open the plastic case of a small relay and cut away the armature mechanism, so that you are left with the relay coil and core. If you are careful you can retain the terminating pins that are moulded in the plastic former to solder the shielded cable to. The relay coil can then be mounted on a strip of aluminium which can then be used as a mounting bracket.

Fishing rod binding thread can be used to fix the coil to the bracket, after which you can use binding varnish to protect it after the wires have been soldered. You can then dip the whole lot in epoxy for further protection or just use a small piece of heatshrink.

Rick Goodwin,
Moonah, Tas. ($25)





Digital thermometer with LCD readout

Unlike the SILICON CHIP design described in December 1998, this digital thermometer obtains its supply from a single 6V battery. In addition, this design includes its own metering circuitry and doesn't have to be plugged into a DMM.

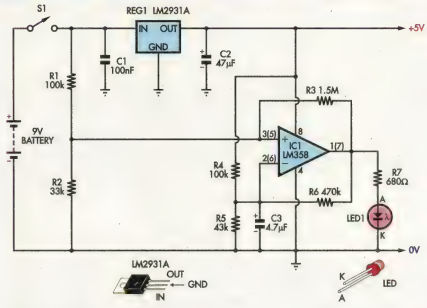
As shown, IC1b is used to amplify the thermocouple output and this drives IC2, an ICL7106 counter/LCD driver. IC2 in turn drives an Hitachi L1331CC 3.5-digit LCD. Alternatively, an LCD panel meter could be used here with just a few minor changes.

IC1a and D1 function as a voltage regulator and this provides a reference voltage to the negative end of the thermocouple and to pin 6 of IC1b. D1 establishes a 0.65V reference on pin 3 of IC1a, while VR1 sets the gain and thus the reference voltage from pin 1.

The prototype thermometer is wall-mounted and uses four AA alkaline cells to ensure long battery life. The counter is wired for a 20V range and calibrated against a known voltage by adjusting VR3.

The calibration procedure for the temperature sensing section is very simple. First, VR1 is adjusted to obtain a 1.500V reading on the IN1LO input of IC2 (pin 30). VR2 is then adjusted until the LCD readout matches the reading from an accurate reference thermometer (eg, the LCD should show 022 for a temperature of 22°C).

K. J. Benic,
Forestville, NSW. ($40)



Low battery indicator

This circuit indicates the remaining battery life by varying the duty cycle and flash rate of an LED as the battery voltage decreases. In fact, the circuit actually indicates five battery conditions:

(1) a steady glow assures indicates that the battery is healthy; (2) a 2Hz flicker (briefly off) indicates that the battery is starting to show age; (3) a 5Hz 50% duty-cycle flash is a warning that you should have a spare battery on hand; (4) a brief flicker on at a 2Hz rate indicates the battery's last gasp; and (5) when the LED is continuously off, it's time to replace the battery.

IC1 is wired as an oscillator/comparator, with a nominal fixed voltage reference of about 1.5V on its pin 2 (inverting) input (actually, it varies between about 1.7V and 1.4V depending on the hysteresis provided via R6). This reference voltage is derived from a voltage divider consisting of resistors R4 & R5, which are connected across the 5V rail derived from regulator REG1, and feedback resistor R6.

Similarly, IC1's pin 3 input (noninverting) is connected to a voltage divider consisting of R1 & R2 which are across the 9V battery.

Using the component values shown, the circuit will switch LED1 from being continuously on to flash mode when the 9V battery drops to about 6.5V. Subsequently, LED1 is continuously off for battery voltages below 5.5V.

Naturally, you can tweak the resistor values in the divider network for different voltage thresholds as desired.

In operation, the circuit oscillates only when the sampled battery voltage (ie, the voltage on pin 3) is between the upper and lower voltage thresholds set on pin 2. Capacitor C3 provides the timing.

Above and below these limits, IC1 simply functions as a comparator and holds LED1 continuously on or off.

Finally, to precisely set the "dead-battery" threshold, make R4 adjustable to offset the variations in regulator tolerance.

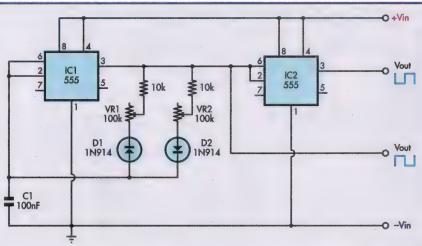
Ashish Nand,
Melton South, Vic. ($35)

555 timer circuit with variable on/off times

This circuit enables the on/off times of a 555 timer to be independently varied over a wide range. This is not possible with a conventional 555 circuit with the RC network being charged from the positive supply rail and discharged via pin 7.

Instead, the capacitor at pins 2 & 6 of IC1 is charged and discharged from the output at pin 3. Furthermore, the charging and discharging circuits are different, being isolated by diodes D1 & D2. Therefore the capacitor at pins 2 & 6 is charged via diode D2 and trimpot VR2 and discharged via D1 and trimpot VR1.

With this arrangement you can have very long on times combined with very short off times and vice versa, or you can adjust the duty cycle to exactly 50% and so on.



This circuit also employs a second 555 timer (IC2) as an inverter so that complementary pulses are available, if required. If not, delete IC2.

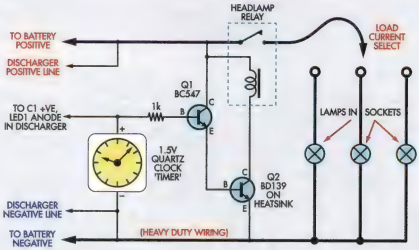
A. Davies,
Canberra, ACT. ($30)

High-current battery discharger

If you have a motley collection of 12V batteries in varying states of health, this simple circuit will allow you to easily check their capacity. It's basically a high-current discharge load which is controlled by the NiCd Discharger published in the November 1992 issue of SILICON CHIP.

A subsequent circuit published in Circuit Notebook, September 2000, showed how to add a clock timer to this discharger, so that the discharge period could be measured. This involved increasing the existing 10µF capacitor across LED1 to 100µF, to enable it to supply the brief current pulses required by the clock mechanism.

The discharger's "clock connection" now controls a BC457/BD139 Darlington transistor pair (Q1 & Q2) via a 1kΩ resistor. These in turn activate a car headlamp relay to switch in a preselected lamp load (one of three).



With 12V selected, the prototype unit stops the discharge at 11.4V which corresponds to a cell voltage of 1.9V (this is a pretty good indication of a discharged 12V battery).

The loads consist of three automotive lamps, selected to provide discharge rates to suit the battery being tested. These lamps should be fitted to sockets, so that they can be easily swapped for other lamps with different wattages, if required. That way, the discharge current can be varied simply by changing the lamp wattage.

By the way, this circuit will also work with 6V batteries, provided the relay holds in. This gives an "end-point" voltage of about 5.7-5.8V.

Reg Carter,
Ballarat, Vic. ($25)

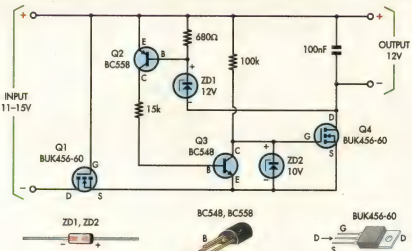
High current low-dropout regulator

This circuit was designed to allow a laptop computer to be powered from a solar power setup. The computer requires 12V at 3.3A.

The circuit is a linear regulator with Mosfet Q4 as the series pass device. A 100kΩ resistor provides Q4 with a positive gate-source voltage. Any tendency for the output voltage to exceed ZD1's voltage causes Q2 to turn on. This turns on Q3 which reduces Q4's gate voltage and thus reduces the output voltage. Note that Q2's base-emitter voltage stabilises at about 0.35V. This combined with the zener voltage gives an output of 12.4V.

If a more precise output is required, first select ZD1 so that its voltage rating is at least 0.4V less than the required output voltage. You can then "trim" to the required output voltage by installing a resistor in series with ZD1.

Q2's base-emitter voltage and the 680Ω base resistor set the current through ZD1 to 0.5mA. This means that the output voltage will be boosted by 0.1V for each 200Ω of resistance in series with ZD1.



Zener diode ZD2 ensures that Q4's maximum rated gate-source voltage is not exceeded. Mosfet Q1 provides reverse polarity protection.

Note that Q4 requires a heatsink since it will dissipate about 10W under worst-case conditions. No heatsink is required for Q1.

At 3.3A, the regulator reduces the output voltage by just 0.2V. This can be further reduced by paralleling Q1 & Q4 with additional Mosfets.

Andrew Partridge,
Kuranda, Qld. ($35)

Sunset Switch

Want to switch on an appliance at dusk and off again after a few hours or at dawn? This sunset switch can do this automatically for you. It is ideal for security and garden lighting.

By JOHN CLARKE

Pathway lights, entrance foyer lighting, house numbers and outside security lights all need to be lit at the onset of darkness; ie, sunset. Of course you can switch these lights on manually each day when darkness falls and switch them off in the morning but it is too easy to forget. The result is that lights are often left on all day and that can waste a lot of electricity.

What you need is a sunset switch – a fully automatic switch which turns on at dusk and off at sunrise. You probably also want a timer that switches the power off after a few hours (selectable). And we'll throw in manual ON and OFF switching so that you can override the system.

So that's what we've done. The SILICON CHIP Sunset Switch has all of the above features and can switch up to 6A at 240VAC. This gives a total load of 1440W of lights or whatever. The unit is housed in a rugged plastic case with a clear lid which allows the ambient light to be detected by the internal light dependent resistor. There is

Main Features

- Switches on mains power at preset darkness level
- Optional timeout
- Four timeout selections
- Manual on and off switching
- 6A mains switching

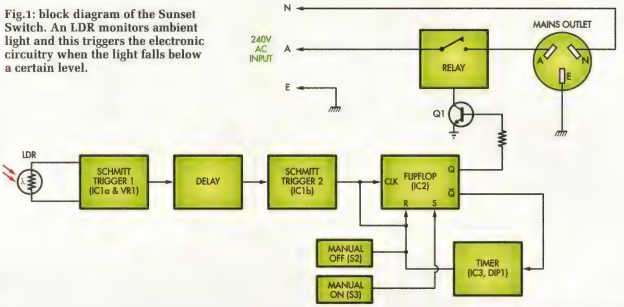


Fig.1: block diagram of the Sunset Switch. An LDR monitors ambient light and this triggers the electronic circuitry when the light falls below a certain level.

also a LED inside the box to indicate whenever power is applied.

Fig.1 is a block diagram showing the operation of the Sunset Switch. An LDR monitors ambient light and when the light drops below a certain threshold, the following Schmitt trigger changes its output level and this is sent through a delay. It takes a few seconds before the second Schmitt trigger changes its output level. This delay prevents momentary changes in light level from causing the circuit to trigger.

The second Schmitt trigger clocks a flipflop and its output drives a transistor (Q1) and the relay. The relay switches power to the mains outlet. At the same time, the flipflop starts the timer and after the selected time (set via the DIP1 switches) it resets the flipflop and the relay is switched off. If the switches are left open, the flipflop will be reset when the LDR receives sufficient light to trip the Schmitt trigger outputs again and reset the flipflop.

Under manual control, the flipflop is set (ON) with switch S3 to turn on the relay and reset (OFF) with switch S2.

Circuit details

Fig.2 shows the full circuit of the Sunset Switch. There are just three ICs and a 3-terminal regulator.

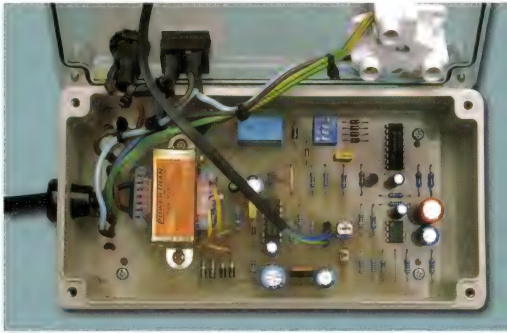
IC1 is an LM393 dual comparator and both comparators are connected as Schmitt triggers IC1a monitors the LDR voltage at its inverting input, pin 2. The resistance of the LDR when exposed to daylight is around 10kΩ, so the voltage at pin 2 of IC1a in daylight is normally below 1V. This is lower than the voltage at pin 3 so the output of IC1a will be high.

In darkness, the resistance of the LDR rises and so the voltage at pin 2 rises above that at pin 3 and the output of IC1a goes low. The 100kΩ resistor between pins 1 & 3 of IC1a provides about 200mV hysteresis which prevents the output from erratically switching low and high as the light level changes.

Trimpot VR1 sets the light threshold for the Sunset Switch. You can set it from twilight to quite dark.

The output from IC1a is fed via an RC delay network consisting of a 100kΩ resistor and 100µF capacitor. This delays the triggering of the following Schmitt trigger, IC1b, by a few seconds. This prevents false triggering due to sudden changes in light level.

Low light levels result in IC1b's out-



This is the view inside the completed unit. Be sure to use mains-rated cable for all 240V AC wiring to the fuse, power switch & mains socket (GPO).

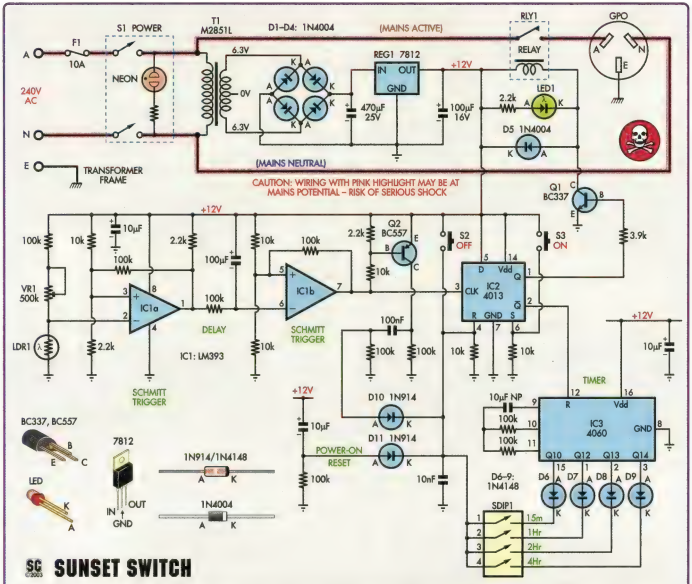


Fig.2: the complete circuit of the Sunset Switch. IC1a & IC1b function as Schmitt triggers, while flipflop IC2 drives the relay (via Q1) and resets timer IC3 (a 4060 counter). VR1 sets the light threshold at which triggering occurs.

put going high and this triggers the clock input of the D-type flipflop IC2 at pin 3. This causes the Q output at pin 1 to go high. This turns on transistor Q1 which powers relay RLY1. LED1 lights to indicate whenever the relay is switched on.

Timer control

At the same time as pin 1 of IC2 goes high, the complementary output at pin 2 goes low and this releases the reset on counter IC3. IC3 includes a free running oscillator at 1.2Hz, as set by the components at pins 9, 10 and 11. As a result, the outputs at Q10, Q12, Q13 and Q14 go high after 15 minutes, 1 hour, 2 hours and 4 hours, respectively. If one of the DIP switches are closed, the selected output will reset flipflop IC2. This causes the relay to switch off.

Should all the DIP switches be open, flipflop IC2 will not be reset by the timer; ie, the timer has no control. In this case, the only way the flipflop can be reset is if the Off switch, S2, is pressed or the ambient light on the LDR increases and causes IC1a and IC1b to respond accordingly; ie, IC1b's output goes low and transistor Q2 turns on. This resets the flipflop via the 100nF capacitor and diode D10.

Manual switch-on is via switch S3 which sets the flipflop so that pin 1 is high and pin 2 is low.

Power for the circuit comes from a mains transformer with a centre-tapped 12.6V winding. This feeds a bridge rectifier consisting of diodes D1-D4 and the rectified output is filtered with a 470µF capacitor. The 3-terminal regulator, REG1, provides the required 12V for the relay and ICs.

IC2 is reset at initial switch-on, by virtue of diode D11 and the associated 10µF capacitor.

Construction

The Sunset Switch is constructed on a PC board coded 10106031 and measuring 138 x 76mm. This is housed in a plastic case measuring 165 x 85 x 55mm which has the control switches and mains socket mounted on the transparent lid. The wiring layout and component overlay for the PC board is

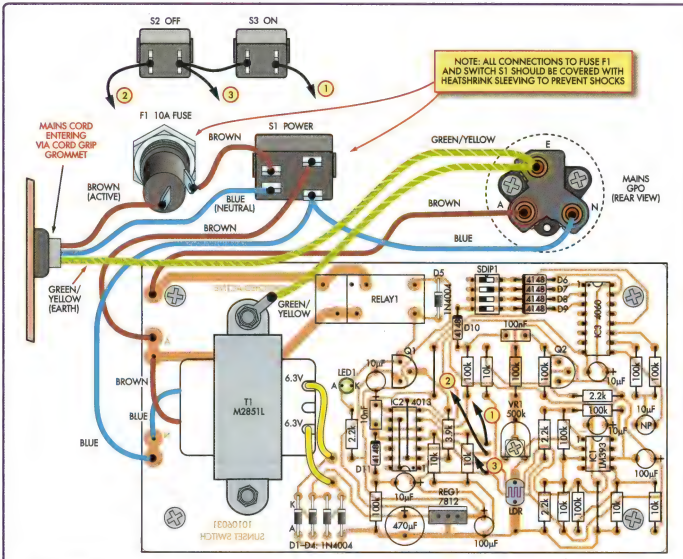


Fig.3: install the parts on the PC board and complete the wiring as shown here. Exercise extreme care when installing the mains wiring and make sure that all exposed terminals are sleeved with heatshrink tubing to avoid accidental contact with the mains voltages.

shown in Fig.3.

You can begin construction by checking the PC board against the published pattern in Fig.6. Check for any shorts or breaks in the tracks. Fix any faults as necessary.

Start assembly by inserting the PC stakes at all the external wiring connection points on the PC board (8 required). Then insert the links and the resistors, using Table 1 as a guide.

Next, you can install the ICs, taking care with their orientation. The DIP switch and trimpot VR1 can also now be inserted and soldered in place.

When installing the diodes, transistors and 3-terminal regulator, take care with their orientation and be sure that the correct transistor is in each position. The electrolytic capacitors must be oriented with the polarity as shown with the exception of the 10µF bipolar (NP or BP) type which can be mounted

Table 2: Capacitor Codes

Value	IEC Code	EIA Code
100nF (0.1µF)	104	100n
10nF (.01µF)	103	10n

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	9	100kΩ	brown black yellow brown	brown black black orange brown
❑	6	10kΩ	brown black orange brown	brown black black red brown
❑	1	3.9kΩ	orange white red brown	orange white black brown brown
❑	4	2.2kΩ	red red red brown	red red black brown brown

Parts List

1 PC board, code 10106031, 138 x 76mm
1 sealed enclosure with clear lid, 165 x 85 x 55mm, Altronics H-0326 or equivalent
1 mounting foot pack (4), Altronics H-0350
1 12V relay with 10A 250VAC contacts; Altronics S-4250A, S-4170A or equivalent (RLY1)
1 chassis-mount mains socket (Altronics P-8241 or equivalent)
1 12.6V 150mA mains transformer with thermal fuse; Altronics M-2851L or equivalent (T1)
1 M205 mains safety panel-mount fuseholder
1 M205 10A fast-blow fuse (F1)
1 DPDT 6A mains rocker switch with Neon (S1)
1 LDR dark resistance 1MΩ light resistance 5kΩ (Altronics Z-1621 or equivalent)
1 4-way DIP switch (SDIP1)
6 100mm long cable ties
1 500kΩ horizontal trimpot (VR1)
1 3mm crimp eyelets
1 red momentary 250VAC pushbutton switch; DSE P-7552, Altronics S-1080 or equivalent (S2)
1 black or blue momentary 250VAC pushbutton switch; Altronics S-1081, DSE P-7550 or equivalent (S3)
1 7.5A mains cord and moulded plug
1 cordgrip grommet to suit mains cord
1 150mm length of 4.8mm heatshrink tubing
1 250mm length of 3.2mm heatshrink tubing
1 150mm length of blue 7.5A mains wire
1 150mm length of brown 7.5A mains wire
1 150mm length of green/yellow 7.5A mains wire
1 200mm length of 3-way rainbow cable
1 100mm length of 0.8mm tinned copper wire
1 M3 x 6mm screw
1 M3 x 15mm screw
3 M3 nuts
2 M3 star washer
10 PC stakes

Semiconductors
1 LM393 dual comparator (IC1)
1 4013 dual D flipflop (IC2)
1 4060 counter (IC3)
1 BC337 NPN transistor (Q1)
1 BC557 PNP transistor (Q2)
1 7812 1A 12V regulator (REG1)
5 1N4004 1A diodes (D1-D5)
6 1N4148, 1N914 diodes (D6-D11)
1 3mm green LED (LED1)

Capacitors
1 470µF 25V PC electrolytic
2 100µF 16V PC electrolytic
3 10µF 16V PC electrolytic
1 10µF bipolar electrolytic
1 100nF MKT polyester
1 10nF MKT polyester

Resistors (0.25W, 1%)

9 100kΩ	1 3.9kΩ
6 10kΩ	4 2.2kΩ

either way around.

The LDR can be mounted with its body about 5mm above the PC board. The LED and relay is mounted next.

Drilling the case

Drill out and shape the hole in the end of the case for the cordgrip grommet. When fitted, the cordgrip grommet must be such a fit that it will continue to hold the mains cord in place even if the cord is pulled with considerable force.

Mark out and drill the front panel for the mains outlet, switches and fuseholder. The cutting template for the mains socket is shown in Fig.5. Then mount the mains socket, switches and fuseholder.

The incoming earth lead (green/yellow) goes direct to the mains socket as shown in Fig.3. A second (mains-rated) earth lead is then run from the mains socket and is either soldered or crimped to a solder lug attached to one of the transformer mounting screws.

Fig.4 shows the mounting details for this solder lug. It is secured using an M3 x 15mm metal screw, two nuts and a star washer. Make sure the transformer case is indeed earthed; ie, check for a short circuit between earth and the transformer mounting.

In some cases it may be necessary to scrape the lacquer coating on the transformer mounting foot to allow a good contact. Secure the other side of the transformer to the PC board using an M3 x 10mm screw and nut.

Next, mount the PC board in the case using the screws supplied with the case and run the remaining connections to the fuseholder, mains switch and mains socket as shown and use heatshrink tubing over the terminals. Tie the wires with cable ties to prevent them breaking and coming loose from their terminations.

Switches S2 and S3 are wired using 3-way rainbow cable which is then sheathed in heatshrink tubing. This prevents the wires from accidentally making contact with any mains terminals.

WARNING

This circuit is connected to the 240VAC mains supply and is potentially lethal. Do not touch any part of the circuit when it is plugged into a mains outlet.

Always remove the plug from the mains before touching the circuit. In particular, this applies to adjustment of trimpot VR1 and when setting of the DIP switches.

Setting up

Set all DIP switches off, plug a test lamp into the mains socket and apply power. Cover the unit and the light should come on immediately. Uncovering the unit should turn the light off.

Trimpot VR1 is best adjusted by trial and error. Switch off power and remove the mains plug. To set the unit to trigger at a darker light level, turn VR1 anticlockwise. To have it switch on at a brighter level, turn VR1 clockwise.

Also test the operation of the Off and On switches. Then check DIP switch S1. Set it to on, plug in the test lamp, apply power and cover the unit. The test lamp should stay on for about 15 minutes. If this is the case, then

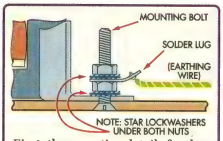


Fig.4: the mounting details for the earth solder lug attached to the transformer.

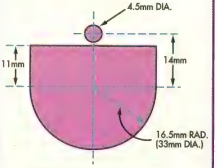


Fig.5: this diagram shows the cut-out template for the mains socket which goes on the front panel.

A length of heatshrink tubing should be used to sleeve the wiring to switches S2 & S3 (see text). Secure all mains wiring using cable ties.

you can expect S2 to switch the lamp on for one hour, S3 for two hours and S4 for four hours.

By the way, if you have more than one DIP switch on, say, S2 and S3, it will give the low setting (15 minutes), not the sum of the two.

If you want longer times, swap the two 100kΩ resistors at pins 10 and 11 of IC3 for larger values. Two 220kΩ resistors should about double these times.

Installation

The Sunset Switch should be installed where it receives outside light. It must not be exposed to the weather. It should also be shielded from the lights that it controls, otherwise it may get into a "race" condition whereby it switches on and off continuously.

Do not drill inside the case to mount it on a wall. Instead, use mounting feet and self-tapping screws into the screw holes on the underside of the case. The mounting feet are available in a pack of four from Altronics. (Cat H-0350). **SC**

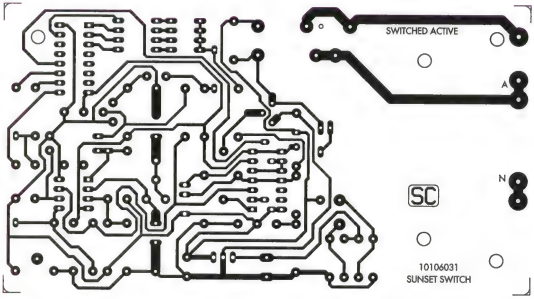


Fig.6: this is the full-size etching pattern for the PC board. Check you board carefully against this pattern before installing any of the parts.

SERVICEMAN'S LOG

Servicing: time really is money

"Time is money" so they say and that applies to servicing as much as anything else. Often, it's far cheaper to simultaneously replace a number of suspect parts in the hope that that will cure a problem rather than waste valuable time nailing down a single culprit.

So what's brought all this on? Well, I have recently been under fire from a reader who suggested that I tend to replace bulk quantities of spare parts (like a "valve jockey"), rather than meticulously measure, test, diagnose and then replace a single faulty part. However, that's usually not the most economical approach.

The fact is, the economics of servicing is changing. Valves have been gone almost 30 years and even sets with multiple plug-in modules have now almost gone. I work in one of the last (dying) industries that actually repairs faults to component level.

Almost everyone else has given up and either replaces a faulty module or even the complete assembly. My approach is the same as that of my colleagues, except that because of lower overheads, I can actually afford to spend a little more time on diagnostics. Most manufacturers encourage module replacement or even exchange the complete item if it's under warranty.

Long gone is the repair of radios, cassettes, toasters, vacuum cleaners, etc unless they are particularly "exotic", or expensive or have sentimental value.

The number of electronic items that are deliberately designed to be non-repairable increases daily, with neither circuits nor spare parts being offered by the manufacturers. For example, repairing items such as remote controls is becoming an ever-increasing challenge – particularly when it comes to opening their sealed cases!

Now VCRs are reaching their cutoff point, with manufacturers no longer repairing them. Support is confined to extended warranty replacement only. DVD players are in the same boat and new small-screen TVs are tottering on the edge. Consequently, the Serviceman's Log is probably going to be more and more concentrated on expensive upmarket electronic equipment until it too finally falls through the economic glass ceiling.

However, having said all that, my first story is an exception to the above as it concerns a 5-year old 34cm TV set.

The set was a Panasonic TC-14S15A (MX-5 chassis), which came in dead after a storm. A quick look around on the inside revealed no obvious damage – not even a blown fuse! Switching the set on gave me all the power rails from the power supply and these could be traced all the way to the horizontal timebase circuitry.

Fortunately, I even had a service manual for the set, though I was somewhat annoyed that the printing was so small that a magnifying glass had to be used to read it. And because it was a poor-quality photocopy, many of the markings were illegible. Still, in today's market, I was extremely grateful for anything at all.

Using an oscilloscope, I soon discovered that there was no horizontal drive from pin 15 of the jungle IC (IC601). My circuit showed this to be a 64-pin high-density chip (M52770) and I measured various voltages and waveforms around the horizontal oscillator (pin 20). In particular, I also concentrated on the x-ray protection circuits around pin 36 that were likely to switch the drive off, as well as peripheral circuits like Q548.

However, after spending more time than was really necessary, I finally came to the conclusion that IC601 itself was the culprit.

I was about to order this IC, when,

to my surprise, I found that we actually had one in stock. I fitted it to the set and my diagnosis proved to be correct, because the set came to life with a bright blue picture. What's more, the on-screen display also worked.

Unfortunately, I wasn't out of the woods yet (much to my annoyance) because I couldn't get a picture or sound – not even from the AV input sockets. However, after some fiddling around, I discovered that all I really had was a totally muted set. By overriding the mute, I found there was a picture of sorts but there was no horizontal or vertical synchronisation.

This time, I concentrated on the sync separator circuit on pins 47, 48, 49 & 53 of the IC. Pin 53 (Vcc) had a nice clean 8.9V on it, as expected, and there was a good clean video signal all the way to pins 48 & 49 from pin 47 (the CVBS video signal went from pin 47 to emitter follower Q161, before being split between pins 48 and 49 of IC601).

It was then I almost accidentally discovered a few clues. I found that by touching my fingers across the vicinity of pins 47, 48 & 49, the sync actually momentarily came good. I also found that some surface-mounted components had never been fitted by the factory – in particular R530, R531, R532 and R533, which are in close proximity to the sync circuit. As Professor Julius Sumner-Miller used to say "Why is this so?"

Well, after these clues, things began to snowball. In particular, had I been a little more attentive to the small details, I would have noticed that the original jungle IC (IC601) was marked M52770ASP. However, because it was marked as an M52770SP on the circuit diagram, I had replaced it with an M52770SP.

By contrast, the spare parts list agreed with the marking on the original device, listing it as an M52770ASP.

Unfortunately, there was no mention of the significance of the 'A' suffix in the service manual. There is, however, a big difference between the two devices, as I subsequently discovered.

My next step was to find a circuit for another MX-5 chassis and to take a look at another MX-5 chassis set that I had in the workshop. In both cases, an 'A' suffix device was used and they didn't have R531, R532 or R533 fitted anywhere. Furthermore, on the original circuit (the one without the "A" device), R530 was changed from 100Ω to 330Ω, R531 was 120kΩ and R532 was 82kΩ – but R533 wasn't fitted at all. As far as I can work out, these resistors provide additional biasing on pin 48.

No spares

Because of the high cost of surface-mounted components, I don't normally keep them as spares. As a result, I drilled small holes through the solder pads and mounted conventional 0.25W resistors in their place.

Bingo! – that completely fixed all the remaining problems. The sound was fully restored, along with a good colour picture. My guess is that the 'A" suffix IC was fitted to later production models.

No doubt there is a Panasonic Technical Information Bulletin with all this data somewhere but I didn't have time to check. In fact, the time spent on this repair was really uneconomical. Still, it's all part of a continuous learning process.

Crook televideo

The shop next door uses a Televideo display to demonstrate various bits of merchandise – that is, until last week when there was a little accident and the set fell on the floor. After that, it didn't work any more and was somewhat sheepishly brought into me by the owner in the hope that it could be fixed.

Items Covered This Month

- Panasonic TC-14S15A 34cm TV set (MX-5 chassis).
- Palsonic TVP-342 televideo.
- Sony KV-F29SZZ TV set (G3F chassis)
- Sony TA-F555ES stereo amplifier

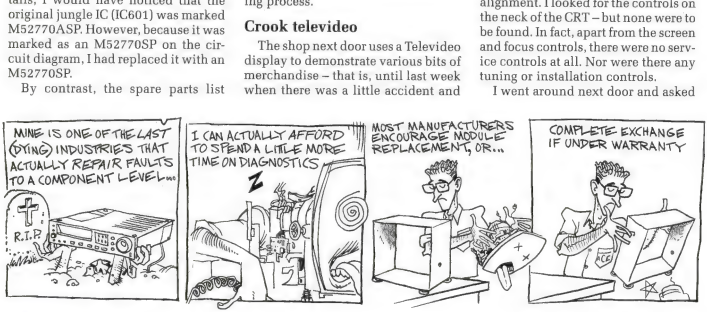
The set was a Palsonic TVP-342, made in Malaysia and available from K-Mart. Despite its fall, it still looked OK apart from a minor crack in the cabinet. However, it was mostly dead.

Removing the covers revealed the main chassis, with the video player on the floor of the cabinet and a small HV board on the top lefthand side. It was this board, which is essentially just the horizontal and vertical timebase and output stages, that was causing the trouble. By wiggling it, I could make the set switch on and off at will.

Finding the crack in the board proved unexpectedly difficult, however. In the end, it turned out to be an almost invisible fracture towards the front top of the board, cutting R588 from C585, D571 from C878 and the earth to CL502A.

When all this had been repaired, I switched on and noticed that the greyscale was far too red and needed alignment. I looked for the controls on the neck of the CRT – but none were to be found. In fact, apart from the screen and focus controls, there were no service controls at all. Nor were there any tuning or installation controls.

I went around next door and asked



for the remote and the Owner's Manual. Unfortunately, after looking all over, they could only come up with the latter. This was indeed unfortunate because the remote control provided the only access to the installation menu.

It wasn't until I ordered a rented service manual that I discovered how to get into the Service Menu and was truly gobsmacked.

First, you have to dismantle the set and remove the lower chassis. Just under the video deck unit, on the righthand front side, next to switch SW955 (Ch-Down) and SW960 (Vol-Up), there is a surface-mounted resistor on the PC board designated R956. To get into the Service Menu, you have to momentarily short its track on the lefthand side (not the righthand side as stated in the Service Manual) to ground. This puts the set into the Service Mode and this is proudly displayed on the screen with a series of "Fs" in each corner.

That done, you can use the remote control (which the client had lost) to make all the service adjustments. However, because I didn't have the remote, I would have had to make multiple use of key No.8 to get to "Red Cut Off", which is what I wanted to adjust.

It's too hard

Frankly, that was just too hard and what finally killed it for me was that the remote control was no longer available from the agents as a spare part.

Basically, you need about six pairs of hands to even enable the Service Mode on this set. You really have to ask yourself why it was designed this way!

Anyway, I don't think next door minds much that the picture is just a bit too red.

Degaussing circuits

Degaussing circuits have given a fair bit of trouble over the years, mostly due to the dual posistor failing. A dual posistor is a small plastic-covered device with three terminals and two ceramic-like discs inside. One has a positive temperature coefficient resistance and the other negative, so when the power is applied a large current flows through the degaussing coils and drops off quickly as the assembly heats up.

I'm not sure what causes these devices to fail but most times the ceramic discs disintegrate and short out, causing the main fuse to fail violently. Usually, there are small clues beforehand, when the device fails to demagnetise the picture tube properly, leaving coloured patches on the screen.

Diagnosing a faulty degaussing circuit is very easy. The first clue is that the set is dead and the fuse has blown. If so, the next step is to measure the resistance across the main reservoir capacitor to make sure it is not low resistance due to a shorted chopper transistor/FET device. You then unplug the degaussing coils and fit a new fuse.

If the sound and picture now come on when power is applied, then you know you are really there. If there is any sign of discoloration near the dual posistor – or if it rattles at all – replace it.

If you are not sure, plug the degaussing coils back in, then switch on and watch the new fuse disintegrate (fuses are cheap). Choosing a replacement can be a nightmare, though – that is, if you are not prepared to wait three weeks or more for an original manufacturer's part at many times the cost of a generic unit. The white ones are mostly Philips units and have different voltages and current ratings, which are hard to comprehend. The black ones have a centre pin, which has three offset positions.

Almost all are interchangeable but will have different performance characteristics; eg, if you put a small current posistor in a large screen set it will not degauss the picture properly. Conversely, a high-current device will have a reduced life due to the low inductance of the degaussing coils.

New sets now have electronic degaussing circuits. These circuits are triggered by microprocessors to reduce the switch-on current of the set. And that leads to a whole new set of fault symptoms being displayed.

Recently, I had a Philips 29PT2252/79R (L01.1A chassis) with intermittent purity coloured patches on the screen. This turned out to be the relay that switched the dual posistor on. Its contacts had become poor and intermittent.

Sometimes, you can attend to a faulty set you haven't encountered before where the symptom is "dead". Initially, you remove the back to be confronted by a bewildering display of electronics – a mosaic of interconnecting modules and a thick wiring harness obscuring everything. This usually happens on large-screen televisions with sophisticated features and situated in very dark corners.

You look at this and wonder where on earth to start. Of course, the customer knows exactly what the fault is – it's the fuse/switch/valve or picture tube. The irony is that sooner or later, a customer will be right!

It's already taken you 10 minutes to

remove the 50 unnecessary screws that hold the back on – and you were lucky to notice the subwoofer lead and disconnect it just before you reefed it right off the speaker cone. Now you have to find a place to put the big heavy back (with its speaker) so that the mains lead can still be plugged in.

Now where is that mains fuse?

You try to follow the mains lead as it slithers in and out through various wiring harnesses and sleeving until it disappears under the picture tube to the on/off switch. Is the fuse there? Next you have to remove the chassis, which is jammed into the front half of the cabinet shell with the tube – and the whole thing is now very unstable because the back isn't on.

Is the chassis screwed in or has it got some of those maddening concealed catches to release it? Of course, the service manual doesn't mention them. Do you push them, pull them, lift them up or down or left to right – oh dear, I just heard it snap. I had no idea it was that brittle!

A lot of chassis are just cussed and will stick for no reason. Some you have to lift up at the back and some have only one screw to hold them in. It's always the one you can't see, naturally – often the black painted one in the darkest corner holding the black plastic chassis into the black cabinet so that it's all perfectly camouflaged.

So far you are lucky. The tube hasn't fallen over when you forced the chassis out and now you can measure continuity all the way from the mains power plug to the switch, fuse and bridge rectifier. That is of course if it isn't a multiple power supply with relays/SCRs on separate boards to switch on the power to sub power supplies. The main fuse is often covered with an opaque plastic guard so you can't tell quickly whether it has gone or not. This cover, like the rest of the set, fights you to the bitter end before it finally comes off or breaks!

The basic rule is that you have to diagnose this set in under 30 minutes or you will start losing money. And it's taken you all that time just to get the chassis out!

Sony KV-F29SZZ

When I first confronted a dead 1995 Sony KV-F29SZZ (G3F chassis) TV, I was cruising as I managed to: (1) get the back off; (2) get the chassis out; (3) find the fuse and establish that power was getting to the set's power supply – all in just 15 minutes.

However, there was absolutely no sign of any life within the set. I identified the line output transistor (Q2591, 2SC4927) on the D Board by its size and heatsink and fortunately managed to sneak my meter probe in far enough to establish that there was +135V on its collector.

But from there on, I was absolutely stuck, despite having its 86-page service manual with its massive foldout circuit diagrams (there are 17 pages of electrical spare parts, or approximately 2000 components).

The primary power supply had five rails splitting off to about seven IC regulators (some switchable) all over the set, plus another five off the flyback transformer. This was not really an extensive array of voltage rails except for the problem of not only finding them on the circuits but also on the set.

Next, I identified and found the line driver transistor (Q2502, 2SC2688) and established that there was also a full +135V on its collector. This meant it was fully switched off, which told me that there was no line drive from pin 18 of the jungle IC (IC304, CXA1587S) which is on the A Board.

This IC is supplied by 9V on pins 10 & 41 and 5V on pin 12. However, some of these voltages were missing. It's also worth noted that this 48-pin high-density IC is mounted on a double-sided board which is rather prone to corrosion on the top side if the set is situated anywhere near the sea or in a damp humid environment.

Last but not least, this set has three microprocessors and there was not even a standby LED coming on. Following the circuit – especially a photocopied one – is really not a job for the fainthearted.

I eventually established that there was no 9V for the horizontal oscillator. I traced this rail back to regulators IC303 and IC683. These operate (in series) from a 15V supply rail to produce the 12V and 9V rails. A quick check of the 15V rail showed that it was at 0V!

The 15V rail is supplied from D Board D604 and the reason for its failure was that R625 (0.1Ω) had expired violently. Replacing this resistor fixed the entire set but just why it had failed remains a mystery – perhaps there had been an accident at some stage during the set's life that had damaged the resistor in some way. Who knows?

The 15V rail fed large chunks of the set and could probably equally as well been discovered by chasing other leads that were available, such as microprocessor 12C and the start-up circuitry. Or I could have started with the primary power supplies and followed each rail from its source to its destination.

In the end, the fault wasn't difficult to find, although it did require a lot of perseverance to trace it back to its source. And of course, you have to do that in the shortest time possible to make the repair financially worthwhile.

And now here's another reader contribution. It comes from J. B., Hampton, Victoria. This is how he tells it . . .

Vintage Sony amplifier

This saga started out on the basis that it would be a simple repair - something that one always seems to optimistically assume!

Serviceman's Log – *continued*

The amplifier in question was a Sony TA-F555ES, a top-of-the-range unit from the early eighties. It had always been a good performer, apart from a few reliability problems due to dry joints on the power supply/speaker protection board.

In this case, the speaker protector was again indicating a fault condition and would not switch in the loudspeakers. In fact, this latest problem had been intermittent for some months and usually resulted in the amplifier not switching in the loudspeakers for about a minute or so after switch on. After that, it would switch the loudspeakers in and the amplifier would operate correctly.

Eventually, the speaker protector refused to operate at all, so off came the covers,. There was a low DC level on one channel (about 0.5V) and the supply voltages were down. And then suddenly, the loudspeaker protector connected the speakers and the amplifier operated with the intermittent condition for another year.

Finally, one day, my wife reported that the amplifier was playing up again. This time, I decided to move it into the workshop and fix the problem once and for all.

The obvious place to start was to check the supply rails. This amplifier has dual ±61V rails – one pair for the output stages and the second pair for everything else after being further regulated to ±40V, ±20V and ±15V.

The two pairs of ±61V rails are generated from separate windings on the transformer. I soon found that there was no power on one side of the centre-tapped transformer for the auxiliary supply and this was traced to an open circuit secondary winding.

My initial reaction was that the unit would have to be scrapped. This is a 100W per channel amplifier and the transformer is quite large. Even if I could buy a new transformer, there's no way I would be prepared to spend the money on an amplifier that was around 16 years old.

Eventually, I decided to see if I could repair the transformer – after all, I had nothing to loose. I removed the shielding and found a thermal fuse just under the paper insulation and, yes, it was open circuit. Replacing it resulted in a functioning transformer.

So what had caused it to fail? Fortunately, I didn't have to look too far – C410, a 0.015µF 100V capacitor across the AC side of the bridge rectifier was short circuit. I replaced this but was rather surprised that the transformer had blown its internal fuse rather than the capacitor exploding. In fact, the capacitor looked quite OK visually, without any signs of stress.

Powering up the unit, I found that both the -20V and -15V rails were well down. Isolating some circuits then revealed that the fault appeared to be in the -20V rail, this then providing insufficient output for the -15V rail. I then noticed that both rails came good when I disconnected the EQ board, so I reasoned that the fault had to be on this board.

In fact, just touching a transistor on the EQ board could induce the fault in the negative rail. Thinking that there had to be a dry joint here somewhere, I pulled out the EQ board and found a number of joints that were suspect. These were all repaired but that only made the fault permanent!

My next train of thought was there was a fault on the EQ board that was loading down the power supply. I subsequently spent an hour or so isolating various sections on the EQ board, looking for the fault. In fact, I went right from one end of the board to the other before finally realising that there was nothing wrong with the EQ board. Instead, there was a problem with the power supply which was not able to deliver sufficient current – something that was confirmed by reconnecting the EQ board and disconnecting the preamp board.

Turning my attention to the power supply, I soon found that C554 was a 0.68µF greencap, not a 1µF 50V electrolytic as shown in the circuit. I removed C554 and found that it was open circuit (no capacitance at all), so I replaced it with a 1.0µF 50V electrolytic, switched on and was greeted with good -20V and -15V rails.

At long last, I seemed to be getting somewhere! However, that wasn't the end of the matter as the +20V and +15V rails had now failed! Looking at the circuit, C504 was used in a similar manner for the positive rail and was also a 0.68µF greencap. Again, it tested as "shot" and replacing it with another 1.0µF 50V electrolytic restored the positive rails.

With the power supply now working correctly, I turned to the speaker protector. This circuit is based around IC401 and all the voltages around this stage looked strange. Eventually, I came to the conclusion that IC401 was faulty and replacing it cured all the problems in this stage.

The amplifier was now ready for testing and all that was needed were a few DC bias adjustments to bring everything up to tiptop condition. Unfortunately, while doing this, my multimeter probe slipped. There was a flash and a loud bang and I had a piece of output transistor in my hair!

My immediate reaction to this is not printable but, having calmed down, I started to assess the damage, I had taken out Q316, Q317, Q318, Q319, Q320, Q321 and a couple of resistors. Replacing the damaged components plus a number of other open circuit capacitors (both greencaps and electrolytics) finally restored the old Sony amplifier to its former glory. If only the probe hadn't slipped! **SC**

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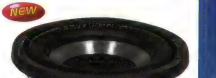

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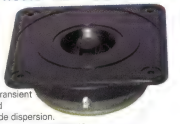

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2" Widerange Speaker

This is an excellent little wide range driver with a large magnet and 8 ohm impedance.

Size 53x53x30mm deep.

NEW

Cat. AS-3020 $3.95

vifa D26 Screened Tweeter

Features a compact design and a neodymium magnet. It has a coated fabric diaphragm, linear response, and is ferrofluid cooled. See cat pg 290 for details.

NEW

Cat. CT-2022 $39.95

USB 2.0 – High Speed Interface

Over 11 times faster than original USB, many peripheral devices eg. CD burners, external storage devices etc., are now supporting this high speed interface. USB 2.0 caters for the high capacity storage and transfer needs of todays world, and still supports original USB devices.

4 Port USB 2.0 PCI Card

Features Plug N Play installation and supports all USB devices up to USB 2.0.

Cat. XC-4817 $54.95

4 Port USB 2.0 Hub

Self powered with the plug pack supplied and conforms to USB 2.0 specification.

Cat. XC-4821 $79.95

USB 2.0 Cables

NEW

All conform to USB 2.0 specification and are 1.8m long.

4 Pin (A) Male to 4 Pin (B) Male

Cat. WC-7700 $9.95

4 Pin (A) Male to 4 Pin (A) Female

Cat. WC-7702 $9.95

4 Pin (A) Male to 4 Pin (A) Male

Cat. WC-7704 $9.95

256MB USB Flash Memory

These lightweight and very portable flash memory devices are small enough to conveniently attach to a keyring. Plug N Play compatible.

Cat. XC-4766 $249.00

NEW

512MB Compact Flash Memory Card!!!

Our largest capacity yet! Great for extra high capacity devices such as high resolution digital cameras etc.

Cat. XC-4781 $329.95

NEW

128MB Smart Media Card

Currently our largest Smart Media card. Great for extra high capacity devices such as high resolution digital cameras etc.

NEW

Cat. XC-4800 $125.00

128MB Multimedia Card

Extremely small and lightweight flash card suitable for use in portable multimedia products such as Digital Cameras, Cellular Phones etc.

NEW

Cat. XC-4789 $189.00

Jaycar ELECTRONICS

Freecall For Orders 1800 022 888

www.jaycar.com.au

Supra High Performance Cable

Made in Sweden

Supra high performance cable is manufactured in Sweden by one of the world's most prestigious cable companies, Jenving AB. In fact Jenving was the first company to manufacture specialised high performance speaker cable in 1976. The introduction of the Supra 2.5 way back then took the cable industry by storm and they have continued to do so.
For the ultimate in sound quality, you can't go past Supra cables.

8GA High Performance Tin Plated OFC Power Cable

The ultimate for high current applications, this multi stranded, OFC cable is tin plated to prevent corrosion and insulated with a translucent, oil resistant PVC jacket.

Cat. WH-3058 $3.75 /m

Cat. WH-3059 $3.75 /m

Classic 2 Core OFC Speaker Cable

Consists of 90 strands of 0.15 tin plated OFC.

Cat. WB-1720 $1.55 /m

Classic 2 Core OFC Speaker Cable with Halogen Free Jacket

Consists of 2 x 322 strands of 0.10 tin plated oxygen free copper wire designed for medium power speaker applications.

Cat. WB-1721 $5.95 /m

Rondo 2 Core OFC Twisted Speaker Cable

Two conductors, each with 322 strands of 0.10mm tin plated oxygen free copper providing excellent conductivity and corrosion resistance.

Cat. WB-1723 $5.95 /m

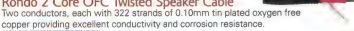
Rondo 4 Core OFC Twisted Speaker Cable

4 conductors, each with 322 strands of 0.10mm tin plated oxygen free copper. They are arranged in a short pitched twist to provide a high tolerance to frequent bending.

Cat. WB-1724 $9.95 /m

Screened Loudspeaker Cable

Eliminates radiation & prevents high frequency interference from other sources. Double screening action provides the best signal to your speakers.



Cat. WB-1725 $7.95 /m

High Power OFC Screened Speaker Cable

Screened OFC speaker cable consists of two cores, each with 192 strands of 0.15 OFC tin plated wire to help eliminate corrosion and enhance long term performance. The drain-wire is also tin plated OFC. Ice blue coloured jacket.

Cat. WB-1722 $13.95 m

BUY THIS:

Programmable Digital LCD Soldering Station

- Adjustable temperature
- LCD digital control
- Lightweight soldering pencil

Cat. TS-1440 $269.95

GET THESE FREE:

Deluxe Tip Cleaner Cat. TS-1510	Worth $12.95
1Kg Roll of 0.71mm Solder Cat. NS-3002	Worth $28.95
A goot Desolder Braid Cat. NS-3027	Worth $4.95

That's $46.85 Value Absolutely FREE!

Pre-programmed TV/Video Remote Control

Controls the primary functions of most TV's and VCR's. Pre-programmed for over 600 devices.
Was $24.95

Save $8

Cat. AR-1701 Now $16.95

Universal 5 in 1 Pre-programmed Remote Control

Controls up to 5 devices, is programmed for over 25,000 pieces of equipment and is easy to use. Limited quantity.
Was $39.95

Save $13

Cat. AR-1709 Now $26.95

OVER 8,500 PRODUCTS IN STORE JAYCAR ELECTRONICS

Twin Blue 12" – 12V Neon Highlight

A set of two, they can be mounted separately or in the stand supplied.
Requires 12VDC @ 400mA.
Was $75.95

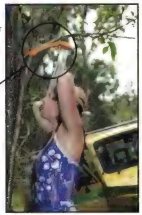
Save $20

Cat. ST-3134 $55.95

GEELONG NOW OPEN SUNDAYS - 10am to 4pm

Turbo Camping Shower

Add a touch of luxury to that outback adventure. Use a bucket of warm water, and your vehicles battery, and enjoy a shower no matter how far from civilisation you are.



Cat. YS-2800 $27.50

Digital Sound Level Meter

Features include data hold, high and low range (35 – 100dB and 65-130dB), and a built in calibration circuit. Powered by a single 9V battery (included) and supplied with a foam insert zip-up carry case, complete with shoulder strap.
See our website for details.

Cat. QM-1588 $179.50

XL RESPONSE Split Speaker/Coaxial Combination

Can be used as coaxials or mounted as a split speaker system. Supplied with mounting hardware, crossovers and wiring harness.
Was $119

Save $30

Cat. CS-2296 Now $89.00

Freecall For Orders 1800 022 888

www.jaycar.com.au

Jaycar ELECTRONICS

3 Input Recording/Monitoring AV Switch Boxes

NEW

These AV switch boxes have functions not normally found in ordinary units. They feature 3 AV inputs, 2 recording outputs, a selectable monitor and auxiliary audio output. They have a handy feature which allows you to switch any of the 3 inputs to either of the outputs. This is ideal for dubbing and editing etc. See Cat page 301 for details.

Composite AV

Cat. AC-1630 $69.95

TWO MODELS AVAILABLE

S-VHS / Audio

Cat. AC-1632 $79.95

Single Event Video Cassette Recorder

NEW

This VHS VCR will record the output of a surveillance camera that has been triggered by a PIR. It can also be triggered by a reed switch on a roller shutter, panic switch etc. This saves an enormous amount of wear and tear on VCR mechanisms that record all the time. Triggering devices must have normally open (NO) contacts. This fantastic Korean made product has a quick response recording mechanism so there is very little delay between the actual trigger and the start of recording. See cat pg 204 for details.

Cat. QV-3058 $499

Colour Full Duplex Multiplexer - 16 Channel

Save $200

- 16 camera inputs
- 6 digit name assignment
- 7 different display modes
- Alarm signal inputs

Was $1395

Cat. QC-3366 $1,195

PLUG N VIEW

Surveillance System

The 'Plug 'N View' do-it-yourself surveillance system is designed for quick and easy installation, yet can be used to develop very sophisticated video monitoring systems. The range consists of a series of cameras, monitors and switchers that simply plug together to form customised surveillance solutions. All cameras in the range use a single cable to carry power, video, audio and PIR signals (where applicable) to simplify installation and operation. But don't be fooled by the simplicity, the Plug 'N View system delivers excellent performance.

The Plug N View range will be available early June.

See in store for our 'Plug 'N View surveillance brochure

3 EASY STEPS TO PLUG N VIEW

1 - Pick a Camera

2 - Pick a Monitor or TV & Switcher

3 - Plug them in

Digital Video Recorder with 4 Channel Real-Time Display

The QC-3052 uses it's own 20GB Hard Disk Drive and in-built software. Although it doesn't require a PC, an RS-232 port is provided for transferring images to a PC for further review, printing, transmitting and editing. NTSC and PAL video outputs are provided to locally monitor video signals. We have made available on our website, the entire list of functions available to the QV-3052. Ltd qty.

2002 Cat Price $3495

Cat. QV-3052 $1795

ALMOST 1/2 PRICE

4 Channel Digital Surveillance Video Recorder DVR

This Professional quality recorder features a 40GB removable hard drive, external triggering, NTSC or PAL capability and password protected settings. The removable hard drive is compatible with our Cat. XC-4670 removable carrier, so the drive can be installed into a PC for further viewing and editing with the software provided. •Switching or four-way split display. •352 x 288 Resolution. •Compatible with any IDE Hard Disk up to 200GB. •Dimensions: 420(W) x 87.9(H) x 318(D). See cat page 205 for details. Ltd qty. **Was $1995**

Save $500

Cat. QV-3060 $1495

4 Channel Surveillance Video Capture Card with Sound

The card incorporates high speed real time compression and digital motion detection. Features include scheduled recording, alarm alert & pre-alarm recording. In addition, the surveillance images can be accessed remotely via a LAN, WAN or even the Internet. It can be set to alert a remote PC and send live video of the alarm camera. For more details see 2002 catalogue page 279. Ltd qty.

Save $350

2002 Cat. Price $849

Cat. QV-3055 $499

Jaycar ELECTRONICS

Freecall For Orders 1800 022 888

www.jaycar.com.au

1000 Watt (2000W Surge) Electrically Isolated 12VDC to 230VAC Pure Sine Wave Inverter

NEW

This inverter is from the same manufacturer as our 150, 300 and 500W sinewaves, so you are assured it works well. It is electrically isolated between the battery and secondary voltage, and can be permanently mounted. The rear panel houses the cooling fan and 12V input terminals, which will accept 2 gauge cable (10mm Dia).

DUE EARLY JUNE

Cat. MI-5088 $899.00

Hot New Books!

NEW

Practical Robotics

Covers in detail the principles of robotics, and everything to get you started. It then moves into mathematical equations, recommended parts and even tools. 338pages.

Cat. BW-1380 $99

Electric Motors & Mechanical Devices

A great compliment to Practical Robotics, it covers the use of servo motors, speed control, and further detailed techniques for working with motors and mechanical devices. 237 pages.

Cat. BW-1382 $69.95

M3 and M4 Metric Taps

NEW

Cuts standard M3 and M4 metric threads. Clean up a cross threaded nut or cut into a chassis or heatsink etc. High quality tool steel.

3mm

Cat. TD-2440 $2.95

4mm

Cat. TD-2442 $3.45

Metal Oxide Varistors (MOV)

120VAC Operating Voltage, 200V Clamping Voltage, 600A Peak Current.

Was $2.20ea

SAVE $18.50

Cat. RN-3409 10 for $2

High Current DC Circuit Breakers

Will work on 12 and 24VDC circuits.

70A Cat. SF-2265

100A Cat. SF-2266

Was $32.95 Save $10

GREAT FOR CAR AUDIO APPLICATIONS

Cat. SF-2265 $22.95

Cat. SF-2266 $22.95

FINAL MONTH - STOCK WON'T LAST

Standard 3mm LEDs 5-15MCD

Cat No	Colour	Normally	25+	100+
ZD-1745	Green	$0.25	$0.14	$0.10
ZD-1750	Yellow	$0.25	$0.14	$0.10

3mm Bi Colour LEDs

Cat No	Colour	Normally	25+	100+
ZD-1739	Red/Green	$0.73	$0.40	$0.30

Standard 5mm LEDs 5-15MCD

Cat No	Colour	Normally	25+	100+
ZD-1710	Red	$0.33	$0.18	$0.12
ZD-1715	Green	$0.33	$0.18	$0.12
ZD-1720	Yellow	$0.33	$0.18	$0.12
ZD-1725	Orange	$0.33	$0.18	$0.12

5mm Tri Colour LEDs

Cat No	Colour	Normally	25+	100+
ZD-1735	Red/Green /Orange	$0.81	$0.45	$0.35

MASSIVE SAVINGS ON LEDS Don't Miss Out!

For all standard/multi-colour/flashing LEDs, the savings are for bulk quantities of one type only i.e. you must buy 25+ or 100+ of the one product to qualify for the discount.

5mm Flashing LEDs

Cat No	Colour	Normally	25+	100+
ZD1730	Red	$1.35	$0.70	$0.60
ZD1731	Green	$1.35	$0.70	$0.60
ZD1732	Yellow	$1.35	$0.70	$0.60

5mm UV LEDs

Cat No	Colour	Normally	25+	100+
ZD1976		$5.50	$3.50	$3.00

10mm LEDs

Cat No	Colour	Normally	25+	100+
ZD-1957	Green	$0.60	$0.30	$0.22
ZD-1958	Yellow	$0.60	$0.30	$0.22

10mm Bi Colour LEDs

Cat No	Colour	Normally	25+	100+
ZD-1962	Red/Green	$1.00	$0.55	$0.47

10mm Flashing LED

Cat No	Colour	Normally	25+	100+
ZD-1965	Red	$1.70	$0.95	$0.80

Rectangular LEDs

Cat No	Colour	Normally	25+	100+
ZD-1765	Green	$0.35	$0.19	$0.15
ZD-1770	Yellow	$0.35	$0.19	$0.15

All prices are per each

Buy in Bulk & Save up to 60%

***For all of these high brightness LED's, you have the flexibility to mix and match within the individual product groups. i.e. You can choose between colours and brightness, though they must all be from the same group ie: ""3mm High Brightness"" group.**

LIMITED STOCKS

3mm High Brightness LEDs

Cat No	Colour	mCd	Normally	Buy 25+ Assorted*	Buy 100+ Assorted*
ZD-1752	Red	120	$0.42	$0.21	$0.17
ZD-1753	Red	900	$0.75	$0.38	$0.30
ZD-1757	Red	5000	$1.60	$0.80	$0.64
ZD-1754	Yellow	2000	$1.05	$0.53	$0.42
ZD-1758	Yellow	5000	$1.60	$0.80	$0.64
ZD-1755	Green	350	$0.81	$0.41	$0.32
ZD-1991	Green	3500	$3.45	$1.73	$1.38
ZD-1990	White	3000	$2.96	$1.48	$1.18

5mm High Brightness LEDs

Cat No	Colour	mCd	Normally	Buy 25+ Assorted*	Buy 100+ Assorted*
ZD-1792	Red	500	$0.53	$0.27	$0.21
ZD-1777	Red	6500	$1.10	$0.55	$0.44
ZD-1795	Yellow	160	$0.53	$0.27	$0.21
ZD-1778	Yellow	5000	$1.00	$0.50	$0.40
ZD-1794	Green	80	$0.53	$0.27	$0.21
ZD-1779	Green	6000	$5.95	$2.98	$2.38
ZD-1998	Blue	2000	$2.50	$1.25	$1.00
ZD-1999	Blue	3000	$3.00	$1.50	$1.20

10mm High Brightness LEDs

Cat No	Colour	mCd	Normally	Buy 25+ Assorted*	Buy 100+ Assorted*
ZD-1970	Red	1600	$0.70	$0.33	$0.26
ZD-1974	Red	3000	$0.95	$0.55	$0.45

Prices correspond to individual products, when purchased in a total quantity of above the required volume.

Titanium Subwoofer and Enclosure Deals

NEW

Refer to Silicon Chip Magazine March and May issues for details.
Using our 10" Titanium Response subwoofers, 10" 25L sealed subwoofer enclosures and a few other bits and pieces, they have created two excellent subwoofer systems. They feature excellent power handling, frequency response, and small size enclosures. As a bonus, if you purchase all the parts listed together, you can save even more money! They are both excellent subwoofers and great value for money. Please note that to complete the projects, a few common parts are required eg. liquid nails, plastic pipe, tools and reference to the relevent issues of Silicon Chip Magazine should be made.

Single 10" Titanium Subwoofer and Enclosure Deal

Refer to Silicon Chip March 03.

This project requires:

1 x 10" Titanium Response Subwoofer	**CS-2274**	**$99.00**
1 x 25L Sealed Subwoofer Enclosure	**CS-2520**	**$59.50**
1 x 650gsm Acrylic Speaker Damping Material	**AX-3694**	**$10.50**
1 x 10" Steel Protective Grill and Grill Clamps	**AX-3522**	**$7.95**
2 x 65mm dia. Flared Speaker Ports	**CX-2688**	**$9.90**
	TOTAL	**$186.85**

Buy all these parts together at one time in any Jaycar store, and we will give you the speaker ports and steel grill absolutely FREE!

Buy All Together: $169.00

Save $17.85

Cat. AA-0138

Single 10" Titanium Subwoofer and Enclosure Deal

Double 10" Titanium Subwoofer and Enclosures Deal

Refer to Silicon Chip May 03.

This project requires:

2 x 10" Titanium Response Subwoofer	**CS-2274**	**$198.00**
2 x 25L Sealed Subwoofer Enclosure	**CS-2520**	**$107.00**
1 x 650gsm Acrylic Speaker Damping Material	**AX-3694**	**$10.50**
2 x 10" Steel Protective Grill and Grill Clamps	**AX-3522**	**$15.90**
4 x 65mm dia. Flared Speaker Ports	**CX-2688**	**$19.80**
	TOTAL	**$351.20**

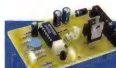
Buy all these parts together at one time in any Jaycar store, and we will give you the speaker ports and steel grills absolutely FREE!

Buy All Together: $315.50

Save $35.70

Cat. AA-0139

Double 10" Titanium Subwoofer and Enclosure Deal



LOOKING FOR AN OLD KIT?

If you are, we may have it in our Kit Back Catalogue. The 'Kit Back Catalogue' range is listed on the Jaycar website (under Kits & Projects) and can only be purchased via the website "www.jaycar.com.au" or Techstore (i.e. not the Jaycar stores).

OVER 5,500 PRODUCTS IN STORE

YOUR LOCAL JAYCAR STORE

NEW SOUTH WALES	
Bankstown	•Ph (02) 9709 2822
Bondi Junction	•Ph (02) 9369 3899
Brookvale	•Ph (02) 9905 4130
Campbelltown	•Ph (02) 4620 7155
Erina	•Ph (02) 4365 3433
Newcastle	•Ph (02) 4965 3799
Parramatta	•Ph (02) 9683 3377
Penrith	•Ph (02) 4721 8337
Silverwater	•Ph (02) 9741 8557
St. Leonards	•Ph (02) 9439 4799
Sydney City	•Ph (02) 9267 1614
Wollongong	•Ph (02) 4226 7089
VICTORIA	
Coburg	•Ph (03) 9384 1811
Frankston	•Ph (03) 9781 4100
Geelong	•Ph (03) 5221 5800
Melbourne	•Ph (03) 9663 2030
Ringwood	•Ph (03) 9870 9053
Springvale	•Ph (03) 9547 1022
QUEENSLAND	
Aspley	•Ph (07) 3863 0099
Brisbane - Woolloongabba	•Ph (07) 3393 0777
Gold Coast - Mermaid Beach	•Ph (07) 5526 6722
Townsville	•Ph (07) 4772 5022
AUSTRALIAN CAPITAL TERRITORY	
Canberra	•Ph (02) 6239 1801
TASMANIA	
Hobart	•Ph (03) 6231 5877
SOUTH AUSTRALIA	
Adelaide	•Ph (08) 8231 7355
WESTERN AUSTRALIA	
Perth	•Ph (08) 9328 8252
NEW ZEALAND	
Newmarket - Auckland	•Ph (09) 377 6421
Glenfield - Auckland	•Ph (09) 444 4628
Wellington	•Ph (04) 801 9005
Christchurch	•Ph (03) 379 1662
Freecall Orders	•Ph 0800 452 9227

Sunset Switch - Upgraded version of Silicon Chip Design

Ref: Silicon Chip June 2003

Switches on mains power at a preset darkness level. We have upgrade this kit from the original Silicon Chip design to switch 240V/10A from the original 240V/6A design. Kit supplied with PCB, electronic components, silkscreened front panel.

Cat. KC-5359 **$79.95**

NEW KIT

BETTER THAN THE ORIGINAL DESIGN

12V LED Lighting for your Car!

These kits can replace the stop/tail, centre high mount stop light, wedge lamp, and festoon (interior) lamps. This gives you great freedom to choose whatever colour/intensity LED's you wish. All projects are designed for 12VDC applications. **All kits are supplied with the PCB(s) and instructions ONLY.**

PC Board for 31mm Festoon Style (Interior Light) Kit

Ref: Silicon Chip March 2003

- Replaces 12V filament lamps with 2 LED's.
- Great for upgrading your interior light or introducing extra highlights inside the car.

NEW KIT Cat. KC-5354 **$4.95**

PC Board for Centre High Mount Stop Light (CHMSL) Kit

Ref: Silicon Chip March 2003

- Replace an existing 12V CHMSL with 16 LED's.
- Add a CHMSL to your vehicle or trailer.

NEW KIT Cat. KC-5356 **$8.95**

PC Board for LED Bayonet Style Lamp Kit

Ref: Silicon Chip March 2003

- Replaces 12V filament lamps with 12 LED's.
- 12 LED design.

NEW KIT Cat. KC-5349 **$8.95**

PC Board for 41mm Festoon Style (Interior Light) Kit

Ref: Silicon Chip March 2003

- Replaces 12V filament lamps with 3 LED's.
- Great for upgrading your interior light or introducing extra highlights inside the car.

NEW KIT Cat. KC-5355 **$4.95**

PC Board for Wedge Lamp Kit

Ref: Silicon Chip March 2003

- Replaces 12V filament lamps which use the 'Wedge' style lamps with 9 LED's.

NEW KIT Cat. KC-5357 **$8.95**

Jaycar ELECTRONICS

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www.jaycar.com.au

PRODUCT SHOWCASE

MemoDisk USB Flash Drive

Remember the days, not so long ago, when your only means of transferring data from one machine to another was the floppy disk?

Nowadays there is a plethora of storage devices, many of them highly mobile. But this MemoDisk from Oatley Electronics must be right up there with the best of them.

It's shown same size at right. With up to 1GB capacity, it simply plugs in to your PC's USB port and behaves like another hard disk (the pocket clip cap comes off revealing a USB plug). Anything you can store on a hard disk can be stored on the MemoDisk. When you leave, you can unplug it (even when the machine is still on) and take your data with you.

It works with Win98SE, Win2000, WinME, WinXP, WinCE, Linux 2.4 or higher and Mac 9.0 or higher. For those with Win98 (which does not support USB Mass Storage Driver) a software driver is included. WinNT is not supported.

There is a write-protect switch to prevent accidental erasure and data can be password protected.

For security, for transferring data, for ease of use it's a real winner. Prices start at $24 for a 16MB up to $165 for a 256MB. The 128MB model shown sells for $82.

It comes complete with a USB to USB cable for those who have geographically challenged USB ports, a lanyard (for wearing the Memo-Disk around your neck), instruction manual and mini CD with drivers and utilities.

Contact:
Oatley Electronics
PO Box 89, Oatley NSW 2223
Ph: (02) 9584 3563 Fax: (02) 9584 3562
website: oatleyelectronics.com

"Jasper" precision circle-cutting jigs for speakers

Cutting holes in speaker boxes has always been a time consuming job, often with less than perfect results - wrong size, uneven edges, much sanding required etc. Now the Soundlabs Group stocks JasperAudio precision circle jigs – they make light work of cutting holes. You can even make a rebate to mount the driver level with the wood panel!

JasperAudio manufactures precision router jigs for cutting circles, mortises and arcs with a plunge router. The jigs are manufactured in the USA to high quality standards and accuracy. JasperAudio have the first one pass circle jig that requires no trial cuts. No sanding will be required to get a precision circle cut-out every time. 3 models are available and they will work with most common routers. Much more information is on the Soundlabs Group website.

Contact:
Soundlabs Group
PO Box 307, Surry Hills, NSW 2010
Ph: (02) 9660 1228 Fax: 02 9660 1778
website: soundlabsgroup.com.au

Small safety relays from Pilz

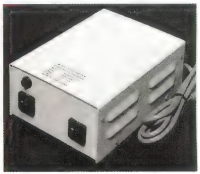
Two new compact Category 4 safety relays from Pilz offer three safe outputs and an auxiliary, making more of small spaces and simplifying the wiring of safety systems. With housings measuring just 22.5mm, both new Pilz relays maximise the limited space in control cabinets and are easy to install.

The flexible Pilz PNOZ X2.7P and the PNOZ X2.8P safety relays are suitable for safety gates, emergency stops, start switches and light curtains.

Four operating modes are available, including single channel mode; dual channel modes without shorts detections across contacts; dual channel mode with shorts across contacts detection; and monitored manual start. The PNOZ X2.8P also features an automatic reset function.

Contact:
Pilz Australia Industrial Automation
9/475 Blackburn Rd, Mt Waverley Vic 3149
Ph: (03) 9544 6300
website: pilz.com.au

STEPDOWN TRANSFORMERS
60VA to 3KVA encased toroids



Harbuch Electronics Pty Ltd
9/40 Leighton Pl. HORNSBY 2077
Ph (02) 9476-5854 Fx (02) 9476-3231

Observations on CeBIT Australia 2003

There are only five CeBIT shows in the world – Hannover, Istanbul, Shanghai, New York and, just as the June issue went to press (early May), in Sydney.

The three-day show, held thoughout three halls of Sydney's Darling Harbour Exhibition Centre, was on target to attract more than 20,000 visitors compared to just over 13,000 the year before.

CeBIT Australia was 50% bigger in 2003 with more than 400 companies exhibiting.

While international exhibitors were down nearly 50%, with 134 international exhibitors in 2002 to 78 in 2003, 140 international delegations attended compared to 102 last year. Organisers claimed both the Iraq war and SARS scares contributed significantly to the downturn. To counter this, there appeared to be a very much higher local representation of international companies.

CeBIT is not your typical "computer show": it is intended as a business-to-business show (with a $25 casual entrance fee to dissuade tyre-kickers). But there was more than enough "gee whiz" gadgetry to gladden the heart of any techno-junkie.

Wireless was everywhere – in fact, the show was heavily promoted as a wireless event – with plenty of opportunity to touch, feel and play with wireless product. Australian wireless provider, Simply Wireless, designed, deployed and managed Australia's largest "Wireless Experience" for CeBIT 2003.

20 Cisco 1200 access points, with the ability to handle several thousand concurrent users, provided network coverage across the halls. Three standards were used – Bluetooth, IEEE 802.11a and 802.11b.

Privately, show organisers expressed some disappointment that the system was never truly tested. While the many wireless products exhibitors put the wireless networks through their paces, it was hoped that many visitors would bring their wireless equipped PDAs, notebooks etc, with them.

Such proved not to be the case, perhaps demonstrating that wireless still is an emerging technology.

One of the most striking features of the show was the number of LCD (and Plasma) screens. There must have been thousands of them, in all shapes and sizes. If anyone had something to demonstrate, it was there on a flat display. Samsung even had a coffee table made out of one! (Now there's a thought . . .)

In the whole show I noticed only three CRT displays – and two of these were "built-ins" on existing equipment.

In his "Publisher's Letter" back in December 2002, Leo Simpson argued that the days of CRT video monitors were over (and he recalls, copped a bit of flack for such an outrageous statement!). Here it is, just five months later – and any of those detractors who visited CeBIT would now have that strange taste of words in their mouths.

While many displays were of the "garden variety" (17-inch or so) size, there were some particularly impressive large-screen displays on show.

Notebooks were everywhere. If not being demonstrated for sale, they were being used to demonstrate applications and hardware for sale. I must confess to being taken aback by one major international exhibitor demonstrating their new offerings with, wait for it, Pentium III processors up to 1GHz. (Pentium IV models at 3GHz are now becoming commonplace and were on display on other stands).

If that was the "big end" of the show, the opposite must be said of the mobile phones being displayed by several major manufacturers. The new models, many the latest whiz-bang video models, are positively tiny. I don't know about you, but my fat little European-heritage fingers were no match for the miniscule keys on these things. Looking at these new models, one couldn't help wondering if miniaturisation hasn't gone just a tad too far . . .

OK, so that was the gadgetry (I lie – it was about 1% of the gadgetry). But what else did CeBIT have to offer?

One innovation was "future parc", showcasing the research behind the technology of tomorrow. It featured universities, centres of excellence, research centres, business parks and other innovation "greenhouses", showcasing the behind-the-scenes work which will provide the next generation of technology.

Then there were applications – just about every possible application you have ever thought of and perhaps many you hadn't. I believe that if you wanted to do something in IT, there was an exhibitor at CeBIT that would be able to do it for you.

There were also many hardware applications, some not even on the market yet. We hope to have a look at some of these in some detail in future months. For example? A sub-$600 onboard vehicle interactive satellite navigation system.

There were the usual "hole in the wall" retailers (and wholesalers) selling everything from systems to motherboards to disk drives to cases to, well, what do you want today? One thing I like about shows (and CeBIT was no exception), is finding out about many of the suppliers that other resellers use. There are often real savings to be made.

I also like the concept of future parc – you don't normally get to see what is happening behind the scenes.

I spent an afternoon at CeBIT. I saw every stand – but I reckon I could have spent a full day there to really see everything in detail. Hell, I didn't even have time to go for a ride on the rocket (no, I'm not kidding!).

Oh well, there's always next year...

Intel's new speedhog Pentium

Intel's new Intel 875P chipset, formerly codenamed Canterwood, supports dual-channel DDR400 MHz system memory, providing exceptional performance across a full range of multimedia and 3-D intensive applications.

Pentium 4 processors with Hyper-Threading Technology operating at 3GHz can now have an 800MHz system bus instead of 533MHz, the previous highest speed bus.

The new 800MHz bus can transmit information within the PC up to 50% faster than the previous version, allowing users to perform multiple complex tasks with greater responsiveness from their PCs, especially in high end and CPU-intensive applications such as graphics, music and video.

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Intel Australia Pty Ltd
Level 17, 111 Pacific Hwy,
North Sydney NSW 2060.
Tel: (02) 9937-5800 **Fax:** (02) 9937-5899
website: intel.com.au

Affordable DAQ from Fluke

The new Wavetek Meterman 38XR and the 38SW data acquisition packages comprises a 10,000-count, full-function digital multimeter (38XR) with companion Microsoft Windows-based data logging software and PC interface cabling(38SW).

The 38-SW software is simple to use and logs, displays, and stores data from all 38XR measurement functions for later retrieval or further analysis. It can also export data for advanced analysis, charting and reporting in Microsoft Excel.

Contact:
Fluke Australia Pty Ltd
Locked Bag 5004, Baulkham Hills 2153
Tel: (02) 8850 3333 **Fax:** (02) 8850 3300
website: metermantesttools.com

Stainless Steel Panel-mount LCDs

Intelligent Systems Australia has available the Aydin Displays (USA) Vector NEMA 4X Stainless Steel Panel-mount Industrial LCD monitors, specifically designed for industrial use where corrosive or health issues require the use of stainless steel. They provide Industrial Strength with cost effectiveness and the NEMA4 Rating (IP65) means the monitor is sealed against dirt/dust and liquids under pressure.

The monitors, available in 15" and 18" models, with or without touchscreens, are built to withstand shock, vibration and temperature extremes that would cause unreliable operation in an office-grade product. They are. Enclosure style is Panel-mount. Touchscreen options include Capacitive and Resistive in both RS-232 and USB interfaces.

Contact:
Intelligent Systems Australia
PO Box 635, Cockatoo Vic 3781
Ph: (03) 5968 0117 Fax: (03) 5868 0119
website: intelligentsystems.com.au

Low Cost PC-Based Instruments Low Cost PC-Based Instruments Low Cost PC-Based Instruments

DrDAQ - Multi Sensor Data Logger

- Built-in Sensors for Light, Sound & Temperature
- Measures pH - just plug in a standard electrode
- Ideal for Science Data Acquisition & Logging Experiments

Simply plug DrDAQ into the parallel port of any PC, run the supplied PicoScope and PicoLog software and you are ready to collect and display data. DrDAQ uses power from the PC so no batteries are required.

DrDAQ
$217 inc GST

Specifications
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- Connects to Parallel Port
- Overload protection ±30V
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ADC-100 Low Cost PC Based Oscilloscope

- 12 Bit Resolution, Dual Channel
- Plugs Into PCs Parallel Port
- Ideal for Audio & Automotive Electronics

The ADC-100 is a dual channel, 100kS/s oscilloscope, spectrum analyser, voltmeter and frequency meter. Very useful as a general purpose instrument in the field or in the lab.

ADC-100
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- Resolution 12 Bits
- Channels 2 x BNC
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- Voltage Ranges ±50mV to ±20V in 9 ranges
- Scope Timebases 100us/div to 50s/div

ADC-200 PC Based Oscilloscopes

- 8, 12 & 16 Bit Resolution
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The ADC-200 series offer a combination of high speed and high resolution models, with deep memory and advanced trigger functions.

For example the ADC-200 high speed models are ideal for microcontroller and digital circuit applications while the ADC-212 and ADC-216 high resolution models are ideal for monitoring sensors, transducers, vibrations, noise and audio signals.

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Product	Sampling Rate	Analog Bandwidth
8 Bit Series		
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12 Bit Series		
ADC-212/3	3MS/s	1.5MHz
ADC-212/50	50MS/s	25MHz
ADC-212/100	100MS/s	50MHz
16 Bit Series		
ADC-216	333kS/s	166kHz

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Low Cost PC-Based Instruments Low Cost PC-Based Instruments Low Cost PC-Based Instruments

Test your reaction times with a DIGITAL REACTION TIMER

By JIM ROWE

So you think your reaction time is pretty good. Cocky, eh? Well, you might be surprised. This little project will let you test your own or anyone's reaction time and read it out accurately on a digital multimeter. The 'Brake!' stimulus is a large red LED, while the subject's response can be sensed via a pushbutton, foot pedal switch or even an optical detector, set up to sense the light from a car's brake lamp.

Everyone takes a finite time to respond to any stimulus, whether it's the brake lamp from the vehicle in front at 110km/h on the freeway, touching a hot saucepan on the stove or whatever.

There's the short time for the nerve impulses from your senses to travel to your brain, the time for your brain to respond and then a further short time for outgoing nerve impulses to travel to your limbs and stimulate the muscles to produce your reaction.

These three delays or 'latency times' are usually lumped together into a single quantity known as your reaction time: the total time taken for you to actually respond to such a stimulus.

Your reaction time varies depending on whether you respond with your hand or your foot. It also depends on your state of health, alertness, psychological outlook and whether you have recently taken drugs or alcohol.

The reaction time for a normal healthy adult seems to vary between about 150 and 300ms (milliseconds) for a hand response and between 400 and 800ms for a foot response (eg,

It's designed to be a low-cost but accurate short-interval timer, suitable for a whole range of purposes (not only reaction). There is no case (cost saving #1), the push-button switches are mounted in old film cannisters (or anything else you wish – cost saving #2) and there is no output circuitry or display, because the output is read directly on any digital multimeter – cost saving #3.

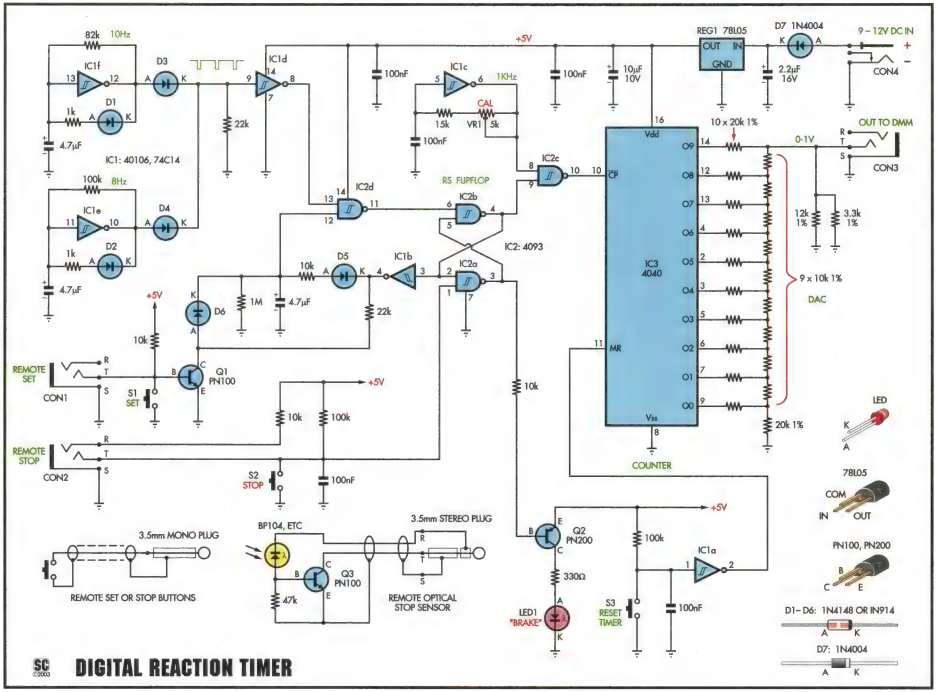
hitting the brakes). If you are driving a vehicle and your measured reaction times are significantly longer than these times, you are an "accident waiting to happen".

You don't need to be a rocket scientist to work out why. Consider driving at 70km/h. At that speed, you're travelling a distance of 19.4 metres every second or almost two metres in each 100ms. So if it takes you (say) 500ms to respond to an emergency by stepping on the brake pedal, your car will travel almost ten metres before the brakes can even begin to slow you down.

Some safety experts have been lobbying for years to make reaction time testing mandatory for driver's licence renewals. It hasn't happened yet – but in the meantime you can measure the reaction time of all your driving friends, to judge whether they should be on the road or not...

Uses a digital multimeter

This new Reaction Timer uses a digital multimeter to read out the time in milliseconds; you just switch it to the 2V DC range.


82k 10Hz
IC1f
IC1d
D3
D1
1k
4.7µF
22k
IC1: 40106, 74C14
100k 8Hz
IC1e
D4
D2
1k
4.7µF
100nF
IC1c
1KHz
CAL
1.5k
VR1 5k
100nF
+5V
100nF
10µF 10V
REG1 78L05
OUT IN GND
2.2µF 16V
D7 1N4004
9 – 12V DC IN
CON4
OUT TO DMM
CON3
10 x 20k 1%
0-1V
12k 1%
3.3k 1%
9 x 10k 1%
DAC
20k 1%
IC2d
IC2c
RS FLIPFLOP
IC2b
IC2a
IC2: 4093
IC1b
10k
D5
1M
4.7µF
22k
D6
IC3 4040
Vdd
CP
MR
Vss
COUNTER
REMOTE SET
CON1
S1 SET
Q1 PN100
10k
100k
REMOTE STOP
CON2
S2 STOP
100nF
LED
7805
COM
IN
OUT
PN100, PN200
3.5mm MONO PLUG
REMOTE SET OR STOP BUTTONS
BP104, ETC
Q3 PN100
47k
3.5mm STEREO PLUG
REMOTE OPTICAL STOP SENSOR
Q2 PN200
330Ω
LED1 "BRAKE"
S3 RESET TIMER
IC1a
D1– D6: 1N4148 OR IN914
D7: 1N4004
SC ©2000
DIGITAL REACTION TIMER

The circuit runs from a 9V battery or DC plugpack. It measures the time you take to press the Stop button (or a foot switch) after the 'Brake!' LED is lit, and converts that time into a DC voltage (1ms = 1mV). So your digital multimeter can read reaction times directly. A reading of 335mV corresponds to a reaction time of 335ms, and so on.

Using a DMM for the readout keeps the circuit simple and the cost low. It also keeps the current drain low as well, so the tester will operate for quite a long time from a standard 9V battery. The current drain is only 4mA when the LED is not lit, rising to 14mA when the LED is on.

Can you jump the gun?

Nope. But you can have fun trying! To make it impossible to 'jump the gun' – even when you're measuring your own reaction time – there's a built-in variable time delay before the 'Brake!' LED is lit, after the Set button is pressed.

So even if you press the Set button yourself, or notice when the operator presses the button, there's no way of guessing when the LED will light. It could be anything from a fraction of a second up to a few seconds, before the LED lights and your reaction time begins to be measured.

You are therefore forced to concentrate on the LED, and then push the Stop button as soon as you see it light up.

The measuring range of the timer is from zero to 1023ms, or just over one second. If your reaction time is longer than this, the timer's output voltage drops back to zero and starts again. This is hardly a problem though, because if your reaction time is longer than 1023ms you should probably be a passenger, not a driver!

How it works

At the heart of the timer is a simple clock pulse generator producing a string of pulses at a rate of one pulse per millisecond (ie, 1kHz).

These clock pulses are controlled by a logic gate, which is opened only during the time that the 'Brake!' LED is illuminated. Pulses from the gate are then fed to a binary counter which counts how many pulses have been allowed through the gate.

We then use a simple digital-to-analog converter (DAC) to convert the count into a DC output voltage, ready for measuring by a DMM.

That's the basic idea. Now we can look at the circuit of Fig.1 in some detail.

The 1kHz clock pulses are produced by the circuitry around IC1c, one section of a 40106 or 74C14 hex Schmitt trigger inverter. This is connected as a relaxation oscillator, with the 5kΩ variable resistor VR1 used to adjust its oscillation rate to exactly 1kHz.

The pulses from IC1c are fed to gate IC2c, the main timing gate. IC2c is one section of a 4093 quad Schmitt NAND gate. The pulses which IC2c allows through are fed to the clock input of IC3, which is a 4040 12-stage binary counter. We only use 10 of the 12 outputs, as this allows us to count up to 1023 (one less than the 10th power of 2).

Ladder DAC

The 10 outputs of IC3 are in binary form, each one swinging between 0V and 5V as the counting proceeds. The combination of 10 binary outputs is converted into an equivalent analog DC voltage by the DAC 'ladder network' of 10kΩ and 20kΩ resistors.

This simple but effective DAC ensures that each output is given the correct 'binary weighting' at the output. That is, the effect of each counter output halves with its position down the ladder. Output O8 produces half the output voltage of O9, O7 produces half that output again and so on.

As this basic DAC produces an output voltage varying from 0V to just on 5V, we use the two additional 12kΩ and 3.3kΩ resistors connected from the DMM output to earth to form the lower half of a voltage divider. This reduces the output voltage range to 0 - 1.023V, ensuring that the DMM will read directly in millivolts.

So IC1c, IC2c, IC3 and the resistor ladder network are essentially the core of the timer, able to count a time period and convert it into an equivalent DC voltage.

Now let's see how we make this timer measure reaction times. Gate IC2c is controlled by an RS flipflop formed from gates IC2a and IC2b (4093). When this flipflop is in the Set state with IC2b pin 4 high, gate IC2c is 'open' and allows 1kHz pulses through to the counter.

At the same time transistor Q2 is turned on by the logic low at the output of IC2a (pin 3), via the transistor's 10kΩ base resistor. This turns on the 'Brake!' LED. This LED remains alight while the timer is actually measuring a reaction time, ie, until the person being tested pushes the STOP button.

When the person being tested presses the Stop button (either S2, or a remote switch via CON2), this pulls pin 1 of IC2a low, which switches the RS flipflop back to its reset state. The output of IC2b goes low, turning off gate IC2c to stop the counter, while the output of IC2a goes high at the same time which turns off Q2 to extinguish the LED.

But what switches the flipflop into the set state in the first place, to start the timer and light the LED? Now that's a little more tricky – which is why we've left it until last.

Random start delay

The flipflop is switched into the set state by applying a brief logic low pulse to pin 6 of IC2b; we could do this by connecting the Set button S1 (or a remote switch via CON1) to this pin via a simple RC debounce circuit like that used for the Stop button S2. But this would turn on the LED and timer immediately, leaving the timer susceptible to errors caused by a subject 'jumping the gun'.

So we've introduced a variable delay between pressing S1 and the actual turn-on of the flipflop, which 'randomises' the turn-on procedure. This works as follows. Schmitt inverters IC1f and IC1e are both connected as relaxation oscillators, similar to the clock oscillator (IC1c) but with both working at much lower frequencies. IC1f runs at about 10Hz while IC1e runs at around 8Hz, determined mainly by the 4.7μF capacitors and the 82kΩ or 100kΩ resistors.

Both these oscillators produce an output in the form of very narrow negative-going pulses. This is due to the effect of the 1kΩ resistors and diodes D1 or D2 which make the 4.7μF capacitors discharge very rapidly on every half-cycle. So both outputs are at the logic high level for about 99% of the time and only at logic low level for about 1% of the time. In other words, the oscillators have a very high duty cycle or mark-space ratio.

Because the two oscillators are running at different frequencies, these narrow negative-going pulses coincide only occasionally. So by combining

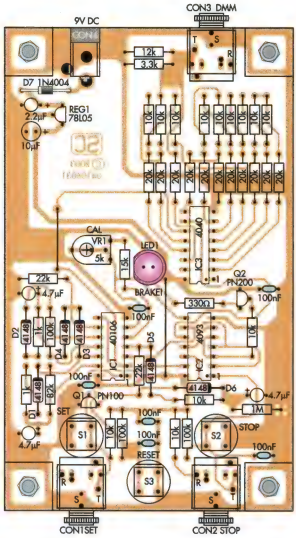


Fig.2: full-size component overlay, along with matching photograph at right. Between these two you should have no problems!

them in the AND gate formed by diodes D3, D4 and the 22kΩ resistor, we end up with a voltage across the resistor which is at logic high level most of the time, only occasionally going low very briefly. This becomes our source of pseudo-random pulses for triggering the flipflop.

The occasional low pulses are inverted by IC1d and then fed to one input of NAND gate IC2d, which controls when they are allowed through to pin 6 of IC2b. The remaining circuitry using Q1, diodes D5 & D6 and inverter IC1b is used to ensure that the flipflop is switched to the set state on the arrival of the first 'random' pulse from IC1d after the Set switch S1 has been pressed.

They also ensure that the flipflop can't be retriggered again for some time, so that it switches to the reset state as soon as the Stop button is pressed, and remains in that state. This works as follows.

While the flipflop is in the reset state, the output of inverter IC1b is high. This means that the 4.7µF capacitor connected between pin 12 of IC2d and 0V could potentially charge up to logic high via D6 and the 22kΩ resistor, except for the fact that transistor Q1 is switched on by the 10kΩ resistor connected to its base.

But if the Set button S1 is pressed, Q1 turns off and the 4.7µF capacitor charges up rapidly, bringing pin 12 of IC2d to logic high level. IC2d then turns on, allowing the next 'random' pulse from IC1d to pass through to the flipflop and switch it to the Set state.

Because of the high value of the 1MΩ resistor connected in parallel with the 4.7µF capacitor, the capacitor takes about 10 seconds to discharge when S1 is released. This means that you only have to press S1 briefly and the circuit remains 'primed' and ready to let through the next trigger pulse from IC1d, even if this doesn't arrive for a few seconds.

But how do we prevent the triggering circuit from being able to turn on the flipflop a second time, after the Stop button S2 has been pressed?

That's the purpose of D5 and its series 10kΩ resistor, because they ensure that any charge on the 10µF capacitor is rapidly drained away as soon as the flipflop is switched on. When the flipflop switches to the Set state, the output of IC1b goes low, D5 conducts and the capacitor discharges through the 10kΩ resistor in less than 100ms.

Reset function

When the timer's flipflop is switched off by the Stop button (S2),

counter IC3 simply stops counting with its outputs remaining at the millisecond count that was reached. This means also that the timer's DC output remains fixed, giving you as much time as you need to read the DMM and record the time reading.

Reset switch S3 resets the counter to zero so you can perform another reaction time measurement. Associated with switch S3 is a 100kΩ resistor and a 100nF capacitor which form a 'de-bounce filter'. This is followed by inverter IC1a which provides a positive-going reset signal for IC3 when the button is pressed.

As well as being a de-bounce filter, the 100kΩ resistor and 100nF capacitor also form a 'power-on reset' circuit to reset IC3 as soon as power is connected to the circuit.

Power for the circuit can come from a 9V battery or 9V DC plugpack. This is fed through diode D7 to prevent reversed-polarity damage and is then passed through 5V regulator REG1.

Trigger options

You have two options regarding the timer's Set triggering. The simpler approach is to use on-board push-button S1 but this means that the person being tested will be well aware when you have 'started the ball rolling'.

The alternative approach is to fit socket CON1 instead of S1 and connect to it a remote pushbutton (or foot switch) via a length of shielded cable and a suitable plug. The remote pushbutton can be mounted in a film container or some other small case that can be handheld.

This allows you to press the Set button out of the test subject's sight (although, as we've said before, there is a random time period after this switch is pushed to prevent cheating!).

The same two approaches are available for the Stop triggering, where you can again use either on-board pushbutton S2 or a remote pushbutton connected via CON2.

In this case there's also a third option; instead of connecting a simple pushbutton via CON2, you can connect a small optical sensor circuit, so the timer can be stopped by an optical signal of some kind; eg, the stop lamp of your car.

In this way, you could simulate an actual braking situation (without the risk of a collision!).

As shown on the circuit, the optical sensor can consist of a BP104 or similar photodiode, a 47kΩ resistor and a PN100 transistor.

Parts List – Digital Reaction Timer

1 PC board, code 04106031, 76 x 128mm
1 momentart contact pushbutton (S3)
2 momentary contact pushbuttons (S1,2) OR
2 3.5mm PC-mount stereo jacks (CON1,2)
1 3.5mm PC-mount stereo jack (CON3)
1 2.5mm concentric power socket (CON4)
4 rubber feet, screw mounting type
4 M3 x 6mm machine screws with M3 nuts
1 3.5mm mono jack plug
1m length of light duty figure-8 cable
2 banana plugs, one red, one black
2 (Optional) 3.5mm mono jack plugs
2 (Optional) 2.5m lengths of shielded audio cable
2 (Optional) pushbutton or foot switches

Semiconductors

1 40106 or 74C14 hex Schmitt trigger (IC1)
1 4093 quad Schmitt NAND gate (IC2)
1 4040 12-stage binary counter (IC3)
1 78L05 3-terminal 5V regulator (REG1)
1 PN100 NPN transistor (Q1)
1 PN200 PNP transistor (Q2)
1 10mm bright red LED (LED1)
6 1N4148 diodes (D1-D6)
1 1N4004 power diode (D7)

Capacitors

1 10μF TAG tantalum
3 4.7μF TAG tantalum
1 2.2μF TAG tantalum
6 100nF monolithic (code 100n or 104)

Resistors (0.25W 1%)

	4-Band Code (1%)	5-Band Code (1%)
1 1MΩ	brown black green brown	brown black black yellow brown
3 100kΩ	brown black yellow brown	brown black black orange brown
1 82kΩ	grey red orange brown	grey red black red brown
2 22kΩ	red red orange brown	red red black red brown
11 20kΩ	brown grey orange brown	brown grey black red brown
1 15kΩ	brown green orange brown	brown green black red brown
1 12kΩ	brown red orange brown	brown red black red brown
13 10kΩ	brown black orange brown	brown black black red brown
1 3.3kΩ	orange orange red brown	orange orange black brown brown
2 1kΩ	brown black red brown	brown black black brown brown
1 330Ω	orange orange brown brown	orange orange black black brown

1 5kΩ horizontal trimpot (VR1)

Putting it together

Virtually all of the timer's circuitry fits on a small PC board measuring 76 x 128mm and coded 04105031. The component overlay diagram is shown in Fig.2.

The only off-board wiring consists of the cables running to your DMM and to a 9V battery or plugpack supply, plus those to the remote Set and Stop buttons if you elect to use them.

The PC board assembly is intended to be used 'as is', supported by four small rubber feet.

Before starting assembly, inspect the copper side of the PC board carefully and make sure there are no hairline cracks in the copper tracks, or solder or copper bridges shorting them together. Fix any defects.

Then start by fitting the two wire links to the top of the board. One of

these is just to the left of trimpot VR1, while the other is just to the left of IC2 and IC3. This second link should be made from a short length of insulated hookup wire.

Next, fit the various connector sockets to the board: DC power socket CON4, DMM output socket CON3 and the optional sockets CON1 and CON2 for the remote Set and Stop buttons. Note that the PC board has holes and pads to match either type of commonly available board-mounting 3.5mm stereo sockets, so there shouldn't be any problems.

If you're not fitting CON1 and CON2, you can fit push-button switches S1 and S2 instead, plus the Reset button S3, which goes at the front centre of the board. Note that S3 must be fitted with its 'flat' side towards the back of the board. This also applies to S1 and S2, if you fit them.

Next you can fit trimpot VR1; you may also need to slightly enlarge the PC board holes before the pins will pass through easily. The board has holes to allow either common type of mini trimpot to be fitted.

The resistors can be fitted next, using the colour codes in the parts list as a guide. If you're not confident about reading the colour codes, use your DMM to check the resistor values. It's also a good idea to fit the resistors with their colour codes reading in the same directions, to make checking and troubleshooting easier in the future.

With the resistors fitted, you can fit the remaining low-profile parts: signal diodes D1-D6 (all 1N4148 or 1N914) and the polarity protection diode D7 (a 1N4004). Take special care to fit all of these diodes the correct way around, as shown in the diagram of Fig.2.

If you don't, the timer either won't work at all, or you're likely to get some very strange results...

Once the diodes are soldered in place you can fit the small monolithic capacitors, and then the tantalum and electrolytic capacitors.

Don't forget that the tantalum and electrolytic capacitors are polarised, and must be fitted into the board with the correct polarity. You should find each one's polarity clearly marked on its body, and the positive side is indicated on the overlay diagram to guide you.

If you mount the pushbutton switches in a film cannister or similar, it's a good idea to fit a large flat washer to stop the switch being forced through the plastic due to over-exuberance!

All that remains is to fit transistors Q1 and Q2, voltage regulator REG1, the 10mm LED and the three ICs. The main things to watch here are that you make sure to fit each one in its correct location and with the correct orientation as shown in the overlay diagram of Fig.2.

REG1 is in the same type of TO-92 package as Q1 and Q2, so don't confuse them. Note that some 10mm LEDs don't have a 'flat' moulded into their plastic pack, so the only easy way to check their polarity is by the longer length of their anode lead. Therefore, make sure you fit LED1 to the board with this longer lead on the side nearest IC3.

We suggest that you solder the LED's leads to the board pads with the bottom of the LED package only about 8-9mm above the board. This allows you to bend both leads forward by about 30°, so that the LED is tilted towards the front.

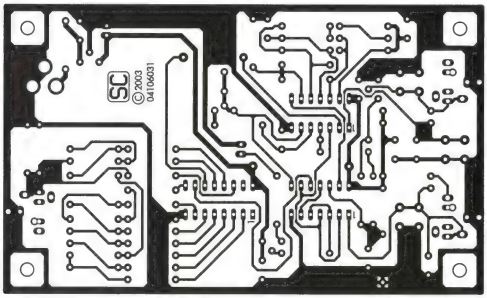
Because all three ICs are of the CMOS type, it's a good idea to take precautions to prevent them from being damaged by static electricity while you're handling and fitting them. The best way to do this is by making sure that the PC board's copper tracks, your soldering iron and yourself are all at earth potential for this part of the operation.

To earth yourself, you can use a conductive wrist strap, connected to an earthed water pipe via a length of flexible insulated wire. This also allows you to drain away any charge on the board copper by simply touching it before you fit the ICs.

Once the ICs are fitted, the final step in the board assembly is to fit the board with small rubber mounting feet, using four M3 x 6mm machine screws and M3 nuts.

You also need to make up a lead to run from the timer to your DMM. This should have a 3.5mm jack plug on one end and a pair of banana plugs at the other. If you use red/black colour coded cable for this lead and fit red and black banana plugs, this will make it easy to connect up to the DMM with the correct polarity every time. Mind you, most DMMs these days have auto polarity, so it's not really a problem.

If you're using remote Set and



Full-size pattern for the single-sided PC board used in this project. It can also be downloaded from WWW.SILICONCHIP.COM.AU

Stop switches, you'll also need to make up the remote switch leads. These can use single-core shielded wire for the plain pushbutton or foot-switch leads, fitted with mono 3.5mm jack plugs. You only need to use shielded stereo cable and a stereo jack plug for the optical Stop sensor, because the extra wire and jack connection are needed for the photodiode bias voltage.

Checkout & calibration

Your reaction timer should now be complete and ready for checkout and calibration. The first step is to connect it to a 9V battery or nominal 9V DC plugpack. Use your DMM to check the voltage at pin 14 of either IC1 or IC2, or pin 16 of IC3 (measured against board earth, such as the lefthand end of the two resistors between CON3 and CON4). You should read +5V at all three of these IC pins.

The LED should not be lit but if you briefly press button S1, the LED should light soon afterwards – within a few seconds. If 10 seconds pass and the LED still hasn't begun glowing, try pressing S1 again briefly. This should cause the LED to light within another few seconds. If not, you've probably made a wiring error. So remove the 9V supply and look for a reversed diode or transistor...

Once the LED does light, try pressing Stop button S2. This should extinguish the LED immediately. If you have connected the timer's output lead to your DMM, it should now indicate a steady DC voltage somewhere between 0V and 1.023V. If you then press the Reset button S3, the voltage should drop back to zero.

Assuming the above checks are successful, your Reaction Timer is working correctly and all that remains is to calibrate it so that your reaction time readings will be accurate. This can be done quite easily, although you do need access to either a calibrated oscilloscope or a frequency counter. These days, many of the better DMMs incorporate a frequency meter.

If you don't have access to either of these instruments, you might have to simply set trimpot VR1 to the centre of its adjustment range and hope for the best.

If you do have access to a calibrated scope or frequency counter, accurate calibration is a snack. All you have to do is connect the (high impedance) input of either instrument to either pin 6 of IC1 or pin 8 of IC2 and read the frequency of the square wave signal. Then adjust VR1 until the frequency reads as close as possible to 1kHz (1000Hz).

That's it. With the clock pulse rate set to 1kHz, the timer's output voltage should be within 2% or better of the reaction time period in milliseconds.

Camera shutter timer?

While we haven't tried it we imagine that this circuit (especially the main timing oscillator, counter and DAC) would also be quite useful as a short interval timer – eg, checking camera shutter speeds. Obviously the "random start" oscillators (IC1e, IC1f) would not be needed, nor would the "Brake" LED or its associated circuitry.

One way to sense the "lens open" time would be to use a phototransistor or photodiode to sense light coming through the lens. Again, we must emphasise that we haven't tried this but we would imagine the phototransistor could be used to simply control IC2c, which in turn would allow oscillator pulses from IC1c into the counter on "light" and stop them on "dark". SC

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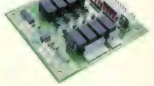

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Jack O'Donnell,
Managing Director

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WITH 1300°C TEMPERATURE PROBE

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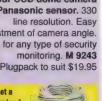

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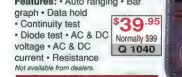

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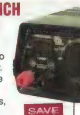

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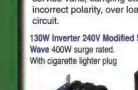

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Adjustable DC-DC converter for cars

Need to run electronic equipment in your car but require more than 12V? Or do you want more voltage than your 12V battery can deliver? This versatile circuit will let you do it. Run your laptop, charge 12V SLA batteries or whatever.

By JOHN CLARKE

AT SILICON CHIP we regularly get requests from readers wanting to power some electronic equipment in their car. Often they want to run a laptop computer in the car or perhaps charge 12V SLA batteries or whatever.

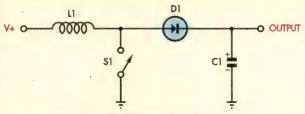
In the past, our standard answer has been to advise them to modify the SLA battery charger circuit from the July 1996 issue. However, that was a bit of hurdle for many readers, so we have improved and updated the circuit to make it capable of delivering any voltage from 13.8V up to 24V DC.

Typically, laptops require 15V DC or more in order to operate correctly and this voltage is not available directly from the car battery. A car battery normally supplies only a nominal 12VDC when the engine is not running and between 13.8V and 14.4V when being charged by the car's alternator. Hence, if you want to run a laptop, you need this DC-DC converter.

The unit is housed in a plastic zippy box measuring 130 x 68 x 43mm and

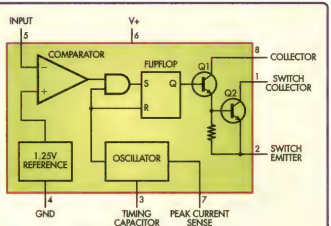
Main Features

- Steps up 12V to between 13.8B and 24V
- Maximum current 2A
- Charge 12V 6.5Ah or bigger SLA batteries
- Efficient switchmode design
- Fuse and reverse polarity protection
- Power indication



BASIC STEPUP CIRCUIT

Fig.1: the basic operating principle of the DC-DC converter. When S1 is closed, current flows through L1, which then stores energy in the magnetic flux produced by the inductor. When S1 opens, the energy stored in the inductor is dumped via diode D1 to capacitor C1 and the load.



MC34063 DC-DC CONVERTER IC

Fig.2 (right): block diagram of the Motorola MC34063 DC-DC converter IC.

can be plugged into your car's cigarette lighter socket. The output can be set to the desired level by adjusting a trimpot.

By the way, for those people who want to run electronic equipment at less than 12V in a car, have a look at the "PowerPack" published in the May 2001 issue of SILICON CHIP. This puts out a regulated supply at 3V, 6V, 9V and 12V.

Performance

The performance of the DC-DC Converter is shown in the graph of Fig.3. The output current ranges from a maximum of 2A at 15.7V, dropping to 1.1A at 24V, while still maintaining full regulation. Mind you, if you want to draw this level of current continuously, you would need to improve the heat dissipation of the circuit. We'll come back to this point later.

Output ripple and noise is quite low, nominally 50mV peak-to-peak when delivering 1A. Load regulation is better than 98% from no load to full load.

How it works

Fig.1 shows the basic operating principle of the DC-DC Converter. It incorporates an inductor, a diode, a switch and a capacitor. When switch S1 is closed, current (I1) flows through the inductor L1 and S1, which then stores energy in the magnetic flux produced by the inductor. When S1 opens, the energy stored in the inductor is dumped via diode D1 to capacitor C1 and the load.

In practice, the switch is a transistor or Mosfet and the on/off times of the transistor's conduction are varied to maintain the desired load voltage. Our circuit uses a Motorola MC34063 DC-DC converter IC as the control device. Its internal circuit is shown in Fig.2.

The MC34063 IC contains all the necessary circuitry to produce either step-up, step-down or an inverting DC converter. Its internal components comprise a 1.25V reference, a comparator, an oscillator, RS flipflop and output transistors T1 and T2.

The switching frequency of the switching transistor (or Mosfet) is set by the capacitor connected to pin 3. We used 1nF to set it at about 30kHz. The oscillator is used to drive the

Performance

Maximum output current	1.1A @ 24V, 2A @ 15.7V
Recommended continuous output	500mA @ 24V, 1A @ 16V
Output ripple	typically 50mVp-p when delivering 1A
Load regulation	better than 98% from no load to full load

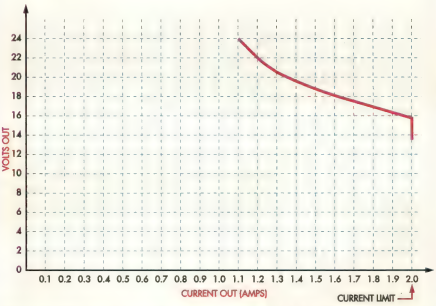


Fig.3: the unit has a maximum output current of 2A at voltages up to 15.7V, dropping to 1.1A at 24V while still maintaining full regulation.

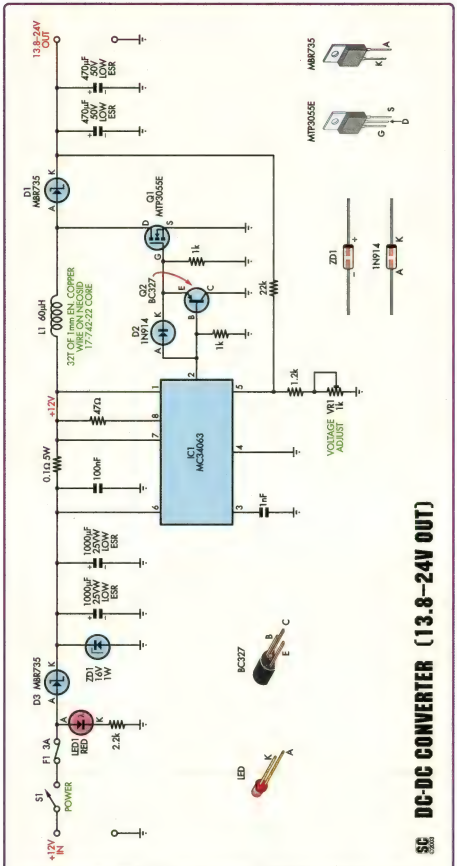


Fig.4: the circuit uses IC1 to drive the gate of Mosfet Q1 via diode D2, while Q2 discharges Q1's gate capacitance each time pin 2 of IC1 goes low. Voltage regulation is provided by the feedback network connected between the output and pin 5 of IC1 (ie, the 22kΩ & 1.2kΩ resistors & trimpot VR1).

flipflop which in turn drives the output transistors. Inductor current is sensed at pin 7 and when this reaches its peak the flipflop and the output transistors are switched off.

The time when the output transistors are switched on is determined by the comparator which monitors the output voltage. When the pin 5 comparator input exceeds the 1.25V reference, which means the output voltage exceeds the required level, the comparator goes low to keep the flipflop from setting. This holds the transistors off.

Conversely, if the output voltage is too low, the inverting input of the comparator will be below the 1.25V reference and so the output transistors can be toggled by the RS flipflop at the rate set by the oscillator.

Circuit details

Fig.4 shows the full circuit diagram of the DC-DC Converter. The internal transistors of IC1 are connected as a Darlington to drive the gate of Mosfet Q1 high via diode D2 to switch it on.

Current then begins to flow in inductor L1. A 0.1Ω 5W resistor between pins 6 & 7 sets the peak current delivered to the inductor to 0.33V/0.1Ω or about 3.3A peak. The average current delivered to the load via diode D2 is limited to 2A.

When pin 2 goes low to turn off Mosfet Q1, transistor Q2 discharges Q1's gate capacitance for a rapid turn-off. This gives better efficiency than if the gate capacitance was discharged via a resistor (as it was in our 1996 design).

Each time Q1 turns off, the voltage at its drain rises because of the energy stored in inductor Q1. Because the current can no longer flow in Q1 it is diverted by diode D1 and dumped in the two 470µF capacitors. Diode D1 is a Schottky type which has a fast response to cope with the high switching frequencies (ie, 30kHz). It also has a low forward voltage which reduces power dissipation and improves efficiency. The output capacitors are low ESR (effective series resistance) types suitable for high frequency switch-mode operation.

Voltage regulation is provided by the feedback network from the output to pin 5. This comprises the 22kΩ resistor from the output and the 1.2kΩ resistor and series 1kΩ trimpot (VR1) connecting to ground. The output volt-

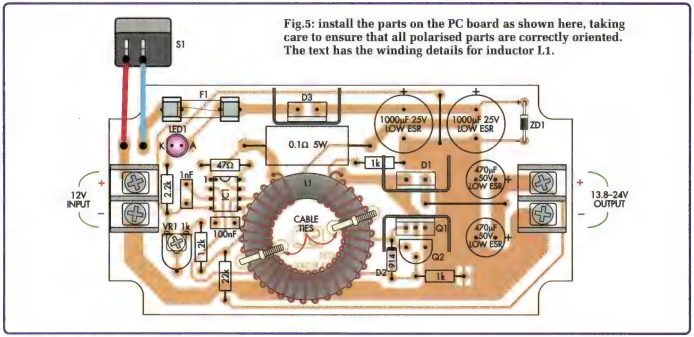


Fig.5: install the parts on the PC board as shown here, taking care to ensure that all polarised parts are correctly oriented. The text has the winding details for inductor L1.

age is maintained when the voltage at pin 5 voltage is equal to the internal reference of 1.25V.

So, for example if VR1, is set to 0Ω, the output will be 24V since when this is divided down by the resistors [ie, 1.2kΩ/(1.2kΩ + 22kΩ) or divided by 19.33], the voltage at pin 5 is 1.25V.

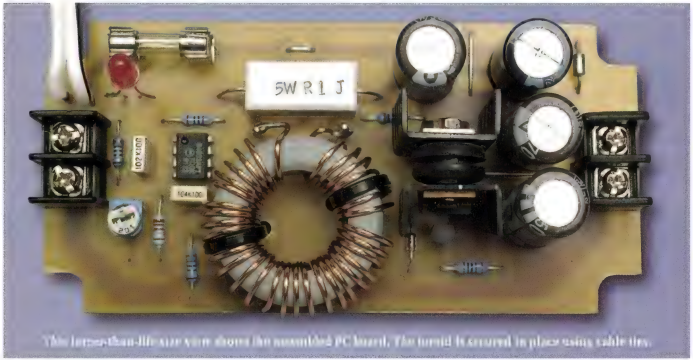
Similarly, if VR1 is set to 1kΩ, the divider now will be (1.2kΩ + 1kΩ)/(22kΩ + 1.2kΩ + 1kΩ) or divided by 11 and so the output will be 13.75V when pin 5 is at 1.25V.

Power for the circuit comes in via a 3A fuse and diode D3, a Shottky power diode included for reverse polarity protection. Supply filtering is provided by two 1000µF 25V low ESR capacitors while further transient voltage protection is provided by the 16V zener diode, ZD1.

There is a secondary reason to include diode D3 and this is to ensure that SLA batteries are not overcharged when the car battery voltage goes as high as 14.4V. Since this is a step-up voltage circuit, it cannot normally deliver less than the input voltage since the Mosfet is permanently off, if this situation is called for. When this happens, there is a direct current path via inductor L1 and diode D1 from the car battery to the SLA battery. Hence, the extra voltage drop via diode D3 helps ensure that SLA batteries are only charged to 13.8V.

Construction

Construction is easy, with the parts all mounted on a PC board coded 11106031 and measuring 120 x 60mm. Fig.5 shows the parts layout.



This larger-than-life size view shows the assembled PC board. The toroid is secured in place using cable ties.

The completed PC board fits neatly into a standard plastic case. Note the rubber grommet between the heatsinks attached to Q1 & D1.

You can begin construction by checking the PC board for shorted tracks or breaks in the copper pattern. Fix any defects you discover before going further. Then insert the PC stakes for S1 and inductor L1 and the wire links.

Insert and solder in all the resistors using Table 1 to guide you in the colour codes. Insert the IC and zener diode taking care with correct orientation. The capacitors can be mounted next, along with trimpot VR1.

The fuseholder clips must be inserted with the correct orientation. The easiest way to make sure the clips are oriented correctly is to fit the fuse into the clips, before inserting them into the PC board. The input and output terminals can now be mounted.

D1, D3 and Q1 are mounted vertically on the PC board, each with a heatsink secured with a screw and nut. Note that diode D1 and Mosfet Q1 are held apart with a rubber grommet spacer between their heatsinks. This grommet is held between the heatsink mounting screws and prevents the two from making contact which would cause a short circuit.

Next, mount Q2 and the LED. LED1 is mounted so that its top is 29mm above the PC board.

Winding the inductor

Inductor L1 is wound with 1mm enamelled copper wire. Draw half the length of wire through the centre of the core and neatly wind on 16 turns, side by side. Then with the other end of the wire, wind on another 16 turns so that the toroid has a total of 32 turns neatly wound around the core. The windings are terminated onto the PC stakes as shown. Make sure that the wire ends are correctly stripped of insulation before soldering, by scraping it off with a sharp utility knife.

L1 is secured in place with two cable ties which loop around it and through holes in the PC board. Spread the windings near Q1's heatsink and the 100nF capacitor so that they are clear of these parts.

The completed PC board is housed in a plastic case measuring 130 x 68 x 43mm. Fit the label to the front panel and drill out the holes for the LED and switch S1. You will also need to drill out the holes at each end of the case for the grommets.

Clip the PC board into the case; it clips into the integral side clips within the case. Test the lid to check that the LED passes through the holes with correct alignment. You can adjust it for best fit and height by bending the leads.

Wire up a cigarette lighter plug or alligator clip connectors to a length of twin automotive wire and pass the other end of the lead through the grommet. Terminate the wires to the input PC board terminals and wire switch S1 as shown. Similarly, connect a second length of automotive wire to the output terminals on the PC board and secure with a grommet.

Testing

To test the unit, first apply power from a 12V battery or DC supply and check that the LED lights. If not, check that the LED is oriented correctly. Now measure the voltages on IC1 with a multimeter. There should be about 12V between pins 4 and 6.

Now connect a multimeter across the output leads and adjust VR1. The

Table 2: Capacitor Codes

Value	IEC Code	EIA Code
100nF (0.1μF)	100n	104
1nF (.001μF)	1n0	102

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	22kΩ	red red orange brown	red red black red brown
❑	1	2.2kΩ	red red red brown	red red black black brown
❑	1	1.2kΩ	brown red red brown	brown red black brown brown
❑	2	1kΩ	brown black red brown	brown black black brown brown
❑	1	47Ω	yellow violet black brown	yellow violet black gold brown

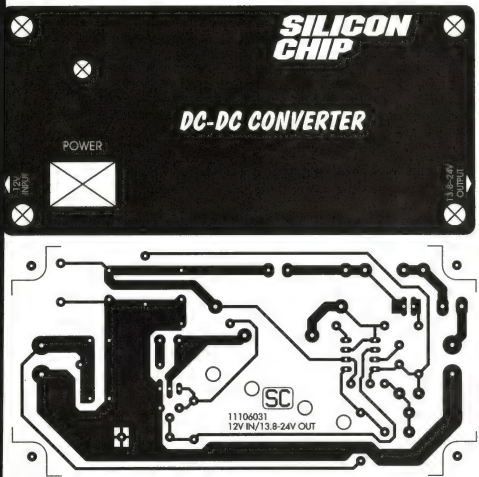


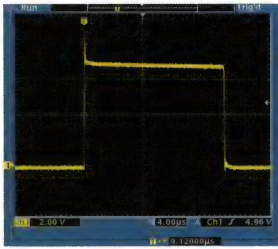
Fig.7: here are the full-size artworks for the front panel and PC board pattern.

voltage range should be from 13.8-24V. Note that the voltage will take several seconds to drop from a higher voltage to a lower setting since the only load is the voltage sensing resistors and these need to discharge the output capacitors.

Set the voltage to that required for your application. If you want to charge SLA batteries, set the output to 13.8V.

Now connect the unit to the appliance using a suitable connector. Be sure the output connector polarity is correct before running the appliance. Check that Mosfet Q1 and diodes D1 & D3 run warm rather than hot.

Finally, if you need to continuously run the DC-DC converter at its full rated output of 2A, it would be wise to run it in a ventilated metal case and possibly use larger heatsinks for Q1, D1 & D3. **SC**



This oscilloscope trace shows the gate drive to the Mosfet Q1. There is almost 11V drive with fast rise and fall times. The fast fall time is improved using the Q2 gate discharge transistor which quickly discharges the gate capacitance.

Parts List

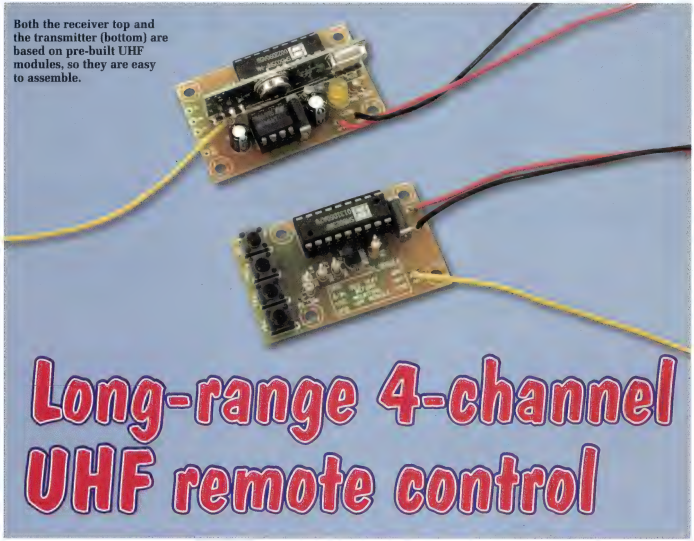
1 PC board, code 11106031, 120 x 60mm
1 plastic case, 130 x 68 x 43mm
1 panel label, 126 x 64mm
1 powdered iron core (Neosid 17-742-22; Jaycar LO-1244; L1)
1 SPST rocker switch (S1)
2 2-way PC-mount screw terminals 8.25mm pin spacing (Altronics Cat. P-2101
3 mini heatsinks, 19 x 19 x 10mm
2 M205 PC-mount fuse clips
1 M205 3A fast-blow fuse (F1)
2 cordgrip grommets
1 14mm OD rubber grommet
1 plug for automotive cigarette lighter socket
1 1m length of red automotive wire
1 1m length of black automotive wire
1 1.2m length of 1mm enamelled copper wire
1 60mm length of 0.7mm tinned copper wire
2 100mm long cable ties
3 M3 x 10mm screws
3 M3 nuts
4 PC stakes
1 1kΩ horizontal trimpot (Coded 102) (VR1)

Semiconductors
1 MC34063 DC-DC converter (IC1)
1 MTP3055E N-channel Mosfet (Q1)
1 BC327 PNP transistor (Q2)
2 MBR735 7A 35V Schottky diodes (D1,D3)
1 5mm red LED (LED1)
1 1N914, 1N4148 diode (D2)
1 16V 1W zener diode (ZD1)

Capacitors
2 1000µF 25V low ESR electrolytic (Atronics Cat. R-6184)
2 470µF 50V low ESR electrolytic (Atronics Cat. R-6167)
1 100nF MKT polyester
1 1nF MKT polyester

Resistors (0.25W, 1%)

1 22kΩ	2 1kΩ
1 2.2kΩ	1 47Ω
1 1.2kΩ	1 0.1Ω 5W



Both the receiver top and the transmitter (bottom) are based on pre-built UHF modules, so they are easy to assemble.

Long-range 4-channel UHF remote control

Do you have an application for a multi-channel UHF remote control? This one has long range, four independent channels and can be built in less than 30 minutes.

By GREG SWAIN

THIS IS BY FAR the longest-range UHF link ever described in SILICON CHIP – over 1km according to Oatley Electronics (the project's developers). It's also by far the easiest to build, thanks to pre-built UHF transmitter and receiver modules.

There are lots of things you could use this 433MHz UHF remote control unit for. Both the transmitter and receiver are smaller than a match box, making it suitable as a hand-held remote control for alarm systems, garage doors and electric door strikers. It can also be used for controlling pumps and gates (eg, on a small farm) and for remote data collection.

It all depends on the circuitry you "hang off" the four outputs on the receiver PC board.

A feature of the transmitter is its four separate pushbutton switches — one for each channel. However, depending on your application, these could be removed and replaced with a cable carrying data from a PC or some other device capable of generating 5V logic signals.

Note too that the transmitter will accept single or simultaneous button presses, or even BCD data. So, by connecting a suitable decoding chip to the receiver, you could control up to 16 separate outputs. For example, you could use a 4514 4-to-16 line decoder for controlling up to 16 outputs or a 4028 BCD-to-decimal decoder for controlling up to 10 outputs.

Pre-built UHF modules

The two pre-built UHF modules are what makes this unit so easy to build. The transmitter module is designated the TX434 and uses a SAW resonator to lock the transmission frequency to 433.92MHz.

This module is truly tiny, measuring just 20mm long x 8mm wide. It has a data rate of 1200pbs (maximum), a frequency tolerance of ±75kHz and operates from a 3-9V DC supply. It also has seven external connections and is installed "surface-mount" style on the back of the transmitter PC board.

At the other end of the link is the complementary RX434 UHF receiver module. This is a full superheterodyne UHF receiver that measures just 44 x 15mm. It is crystal-locked to 433.92MHz, has a sensitivity of 115dBm, operates from a 5V DC supply and has eight external connections (four at either end) which are brought out to pin headers. It is installed directly on the receiver PC board.

Both UHF modules are pre-built and pre-aligned, which means that you don't have to make any adjustments after assembly.

Circuit details

Fig.1 shows the circuit details for the 4-Channel UHF Remote Control. Apart from the UHF modules, the only other components of any real note are the trinary encoding and decoding ICs (IC1 & IC2, respectively). These each have eight coding inputs which can either be individually tied high, low or left open circuit (O/C) to give a "unique" security code. This gives one of 6561 possible combinations but it's really a bit more complicated than this, as we shall see.

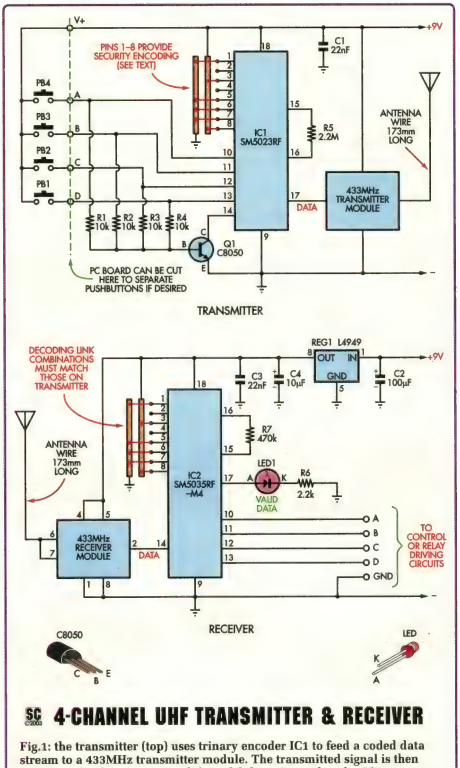
In order for the receiver to acknowledge the transmitter, its trinary decoder (IC2) must have the same connections as the encoder (IC1) – ie, the corresponding pins on the encoder (IC1) and the decoder (IC2) must be connected in the same way (either high, low or open circuit).

Let's take a closer look now at the transmitter circuit. There are four pushbutton switches and when any of these is pressed, its corresponding input on trinary encoder IC1 (either pin 10, 11, 12 or 13) is pulled high. As with pins 1-8, these pins also function as coding inputs. So, when a button is pressed, its corresponding coding input is set to a logic "1" and the code sequence from IC1 is altered.

As a result, the coding sequence from IC1 depends on which button(s) have been pressed, thus allowing us to distinguish between channels.

At the same time, pressing any of the switches also turns on NPN transistor Q1 via a 10kΩ base resistor. This in turn pulls the Transmit Enable pin (pin 14) of IC1 low and so the coded data stream appears at pin 17 of IC1 and gates the UHF transmitter module.

And that's all there is to the transmitter, apart from a 2.2MΩ timing resistor (R5) between pins 15 & 16 of IC1 and a 22nF decoupling capacitor (C1). The unit can be run from any suitable 3-9V DC supply (eg, a 9V battery). Note: do not run the transmitter module from a higher supply voltage, otherwise the maximum permitted output level of 25mW may be exceeded.



SC 4-CHANNEL UHF TRANSMITTER & RECEIVER

Fig.1: the transmitter (top) uses trinary encoder IC1 to feed a coded data stream to a 433MHz transmitter module. The transmitted signal is then picked up by the receiver module and fed to trinary decoder IC2.

Receiver circuit

At the receiver end, the coded UHF transmission is picked up by the RX434 UHF receiver module which then feeds the data stream to IC2, an SM5035RF-M4 trinary decoder. If a

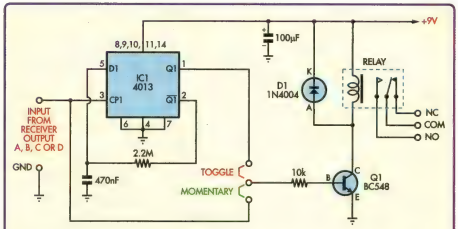


Fig.2: this simple relay driver circuit can be connected to a receiver output and wired for either latching or momentary operation.

valid data code sequence is received, pin 17 of IC2 goes high and lights LED2 via a 2.2kΩ current limiting resistor. At the same time, pins 10, 11, 12 and 13 will momentarily go high, depending on which transmitter button(s) were pressed.

For example, if switch PB1 in the transmitter is pressed, then pin 13 of IC2 will momentarily go high. Similarly, if PB1 & PB3 are pressed simultaneously, then pins 13 and 11 of IC2 will go high, and so on.

Resistor R7 (470kΩ) sets IC2's internal oscillator so that it matches the oscillator in IC1, while capacitors C2-C4 provide power supply decoupling. The circuit is powered from 9V DC, with regulator REG1 (L4949) providing a +5V rail to power the UHF receiver module and IC2.

Momentary or latching?

The trinary decoder specified in this unit is the SM5035RF-M4, which has four momentary outputs – ie, one or more of its outputs momentarily go high when valid data is received on its pin 14 input. In practice, each output goes high for as long as its corresponding transmitter button is held down.

Alternatively, if you want latching outputs, the SM5035RF-L4 can be directly substituted for the "M4" version. This chip will latch its relevant output high if a button is pressed on the transmitter but note that if another button is subsequently pressed, this output will go low again.

This means that if you want two latched outputs on at once, you have to press two buttons on the transmitter simultaneously.

There's just one further wrinkle here – Oatley Electronics do not currently stock the "L4" version of the trinary decoder. However, they do intend making it available in the near future.

Alternatively, if you want a latching relay driver circuit, take a look at Fig.2. It's pretty simple and just consists of a 4013 D-type flipflop (ie, one half of a dual package), a transistor, a diode, a relay, a couple of resistors and a capacitor.

It works like this: each time the clock input (CP1) of the 4013 goes high, its Q1 output (pin 1) will toggle (either low to high or high to low). As a result, the relay either latches on or releases.

If you don't want the latching function, just delete the 4013 and connect the relevant output from the SM5035RF-M4 trinary decoder direct to Q1's 10kΩ base resistor.

Construction

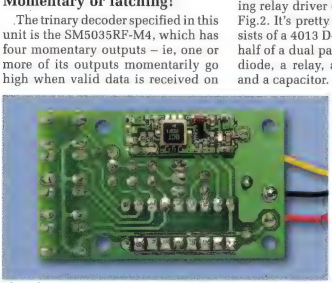
Both the transmitter and receiver are constructed on PC boards measuring just 48 x 29mm. Fig.3 shows the parts layout details.

We suggest that you start with the transmitter assembly. The first thing to do here is to install the miniature UHF transmitter module. This mounts on the back of the PC board (in the position indicated by the screen printing on the top) – see Fig.3.

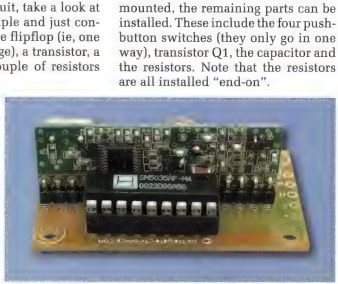
It's just a matter of orienting the module so that its solder pads at either end line up with those on the PC board. Once you have the module correctly aligned, it can be held in position with a clothes peg (be careful not to damage the coil) while you solder the seven connections.

You will need good eyesight, a good light and a fine-tipped soldering iron for this job. If you have a magnifying glass or a "Mag-Lite", then so much the better. It's also best to lightly tack-solder a single connection at either end first, then check the module's alignment before soldering the remaining connections.

Once the UHF module has been mounted, the remaining parts can be installed. These include the four push-button switches (they only go in one way), transistor Q1, the capacitor and the resistors. Note that the resistors are all installed "end-on".



This photo shows how the pre-built UHF transmitter module is mounted on the back of the PC board.



The pre-built UHF receiver module is installed on the receiver PC board via two integral 4-way pin headers.

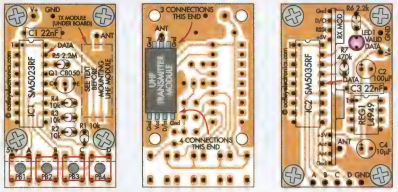


Fig.3: install the parts on the transmitter and receiver PC boards as shown here. You will need a fine-tipped soldering iron to solder in the UHF transmitter module.

It's a good idea to check each resistor value using a digital multimeter before installing it on the board.

The IC socket can go in last. Note that its solder pads along one side sit between two parallel tinned copper tracks. These tracks are quite close to the IC pads, so be careful that you don't get solder bridges between them at this stage.

The two parallel tracks are there to let you set the transmission code – the outside track is at 0V while the other is at +9V (ie, the supply rail). This makes it easy to tie the coding pins (1-8) high or low by creating solder bridges between the pads and the tracks. Alternatively, you can also leave some pins open-circuit (O/C), as stated previously.

For the time being, it's best to leave pins 1-8 all O/C so that there's no confusion when it comes to testing. You can code the unit later on, once it's all working correctly.

Finally, you can complete the transmitter module by plugging in IC1 (SM5023RF) and installing the supply leads and a 173mm-long antenna lead. Take care to ensure that IC1 is correctly oriented – ie, with pin 1 towards the 22nF capacitor.

Receiver assembly

Now for the receiver assembly. This should only take you 10 minutes.

Begin by installing the resistors and capacitors, then install LED1 and the two IC sockets. Take care with the orientation of the electrolytic capacitors and the LED – the flat side on the rim of the LED (cathode) goes towards the 2.2kΩ resistor (R6).

Once all these parts are in, you can install the UHF receiver module. This is installed with its SAW filter (in the round metal can) towards the L4949N regulator (REG1). Push the module down onto the boards as far as it will go before soldering its eight pins.

Finally, complete the receiver module by installing the supply leads and the antenna lead (173mm).

Testing

Now for the smoke test! Check your work carefully, then connect a 9V DC supply to both modules and press each of the transmitter buttons in turn. If the project is working correctly, you should see LED1 on the receiver board light each time a button is pressed.

If it doesn't, disconnect power to both modules immediately and check that pins 1-8 on both IC1 & IC2 are all open circuit (O/C). It's important that both ICs have the same coding, otherwise the unit definitely won't work. Check also for missed solder joints, solder bridges and incorrect component orientation.

If these checks fail to reveal anything, reapply power to the transmitter and check for +5V at the output of REG1 (pin 8). Finally, you can check transistor Q1 in the transmitter by reapplying power and momentarily shorting pin 14 of IC1 to ground. If LED1 now lights, Q1 is probably faulty.

Changing the code

Assuming that the project is working correctly, you can now code the pin 1-8 address lines. As indicated previously, you code each address pin by either leaving it O/C or by bridging it to the adjacent +5V rail or to the 0V rail. Just be sure that the transmitter and receiver codes match. **SC**

Parts List

Transmitter

1 PC board, 48 x 29mm
1 TX434 433.92MHz UHF transmitter module
1 18-pin DIL IC socket
4 miniature pushbutton switches (PB1-PB4)
1 22nF MKT capacitor
1 SM5023RF trinary encoder (IC1)
1 C8050 NPN transistor (Q1)

Resistors (0.25W, 5%)
1 2.2MΩ 4 10kΩ

Receiver

1 PC board, 48 x 29mm
1 RX434 433.92MHz UHF receiver module
1 18-pin DIL IC socket
1 8-pin DIL IC socket

Semiconductors
1 SM5035RF-M4 trinary decoder (IC2) - see text
1 L4949 5V regulator (REG1)
1 red LED (LED1)

Capacitors
1 100µF 16V electrolytic
1 10µF 16V electrolytic
1 22nF monolithic

Resistors (0.25W, 5%)
1 470kΩ 1 2.2kΩ

Where To Buy The Parts

A complete kit of parts for this project is available from Oatley Electronics, PO Box 89, Oatley, NSW 2223. Phone (02) 9584 3563. Prices are as follows:

Transmitter (includes PC board, UHF Tx module plus all parts) $22

Receiver (includes PC board, UHF Rx module plus all parts) $32

Postage and packing is $7 and all prices include GST. Note: the PC board copyright for this design is retained by Oatley Electronics.

Satellite TV Reception:

Our recent feature on installing your own international satellite TV reception system has created a lot of interest. But for at last one reader, it raised even more questions than it answered . . .

by Garry Cratt* and Ross Tester

CAN YOU BELIEVE IT? 100% PERFECT TV RECEPTION

When you hear "Satellite TV" do you think of Foxtel, Optus or Austar? Did you know about *free to air satellite service*?

The free to air service broadcasts programming from the 7, 9 & 10 networks plus has 5 ABC and 4 SBS services. It also picks up 28 radio stations – including World Music. THERE ARE NO ONGOING MONTHLY FEES.

If you have been putting up with poor TV reception because you are in a "Black Spot [redacted] will offer you expert advice regarding the installation of this new technology in your home. *Free to air satellite* will not only give you great TV reception now, but will allow you to make the transition into digital technology without replacing your existing equipment.

[redacted] has been serving the South-East Queensland Region for 20years, repairing televisions and installing television antennas; its highly-qualified European trained technicians are on the cutting edge of exciting new developments in the television industry, specialising in repairs to big screen and rear projection televisions. They are excited to be involved with the new satellite and digital technology and are happy to share their extensive knowledge with you.

Dear *SILICON CHIP*,

I am somewhat confused. Having read the "International Satellite TV" articles (December 2002 & January 2003), I thought I understood what the general message was; ie, that unless we are prepared to pay a service provider, there is little point in playing around with Ku band equipment, because it is (a) illegal and (b) we need a "box" to decode the information – unless one is obtained from an unknown character in a pub (which is also illegal and only operates for a short time) you have to pay up to Austar, Foxtel or whoever.

So as I read it, the (legal) free-to-air stuff available without ongoing costs to the general public is confined to C band.

If one wishes to watch free-to-air satellite TV, the only Australian program which can be seen is ABC Asia Radio Australia, which originates on PAS8; or perhaps Bloomberg Radio/TV, which apparently also has ABC Asia and Radio Australia, which appears to originate in USA (in PAL?) or Fox MUX (whatever MUX means) which is stated to be NTSC and also originates in the USA. These are all on PAS2.

While on holiday, I was surprised to find the attached advertisement in a Gold Coast (Qld) paper for "Satellite TV providing free-to-air programs from the 7, 9 & 10 networks plus 5 ABC and 4 SBS services. It also picks up 28 radio stations including World Music".

I rang the number quoted but it was a Saturday morning and there was no answer. As I was leaving the area next day, I was unable to make any further enquiries.

Can you shed some light on this? Are free-to-air, 7/9/10/ABC/SBS network signals available on Ku band as this advertisement appears to claim? (C.P., Mt Molloy, Qld).

We don't blame you for being confused. Not all is as it appears with that advert! As the proverb says, CP, there are always two sides to every story. The answer is both yes . . . and no.

But before we start on that answer, we should correct one of your assumptions. Watching a program derived from an encrypted Ku-band satellite service is not, as far as we understand the law, illegal.

What is illegal is the manufacture and supply of equipment designed to decode encrypted (ie pay TV) signals without the authorisation of the supplier of those signals (ie, the pay TV company). But as far as the law stands at the moment, it is not illegal to "play around" with Ku-band equipment. If you are a real masochist, you could watch the (unencrypted) TV Home Shopping network 24 hours a day, seven days a week!

Now, as far as "network" programming being available on Ku-band, yes, there are some there. But they are not available, as the advert claims, "no matter where you live." These are specifically intended for remote area services and theoretically require authorised decoders from the various providers. And there are also some inter- and intra-network feeds but these are not meant for normal viewing. In fact, the networks actively discourage viewing these.

Perhaps the information about Aurora on the next page will explain it better . . .

a Postscript

Aurora free-to-air satellite TV

Since 1985 there has been a satellite TV service providing ABC, SBS and several regional stations to viewers in areas not serviced by normal terrestrial services. This service was called the HACBSS (Homestead and Community Broadcast Satellite Service) and used an analog modulation system called BMAC.

In 1998 the new digital "Aurora" system commenced operations, on the Optus B3 satellite, offering a far more powerful signal and superb digital quality picture and audio quality. This new service uses Digital Video Broadcasting (DVB) which involves the use of MPEG compression.

There are advantages for both broadcaster and viewer alike through the use of MPEG. The main advantage to broadcasters is that the new digital service uses less spectrum and hence costs less to operate per channel.

The advantage to viewers is that more channels can be made available at the same price (as analog).

The stronger signal means that systems sold today are able to use much smaller dishes than previously was possible. The smaller dish means a much lower price, making such a system easily available to remote area travellers, mobile home owners and even those who cruise our inland waterways.

Unlike terrestrial TV which is affected by the topography of each location, satellite TV requires only a clear view of (in most cases) the northern sky to operate successfully.

Pay TV has enjoyed some success in the more populated areas of Australia but once you reach "the outback", the technical effort required to receive those services far outweighs the benefits. The Aurora service uses a national beam giving a more even signal over Australia, whereas Pay TV operates on a dedicated zone beam, covering a limited area specifically aimed at the more populated regional areas of Australia.

As an example, Australia's satellite Pay TV operator for country areas "Austar" uses an 11m dish to pick up signals from their own network in Alice Springs for local rebroadcast using a locally based microwave service.

Yet to receive the Aurora service in Alice Springs you only need a 120cm dish.

A satellite receiving system comprises an 85cm dish (suitable for most areas), an amplifier (called an LNBF), a digital receiver, a smartcard and coaxial cable.

Even though the service is free, it does run under a system called "conditional access". The use of a smartcard registered to the end user and his geographic location, ensures that viewers cannot receive programs outside the license area of the broadcaster. This is done to protect the owner of program copyright and regional terrestrial broadcasters.

Apart from a number of closed "subscriber only" services, the ABC operates services in Queensland, Northern Territory, Western Australia, South Eastern Australia (NSW and VIC). SBS also transmits services in Western Australia, Queensland and South Eastern Australia.

It's a great advantage to watch ABC and SBS in all time zones, as it means that if you miss a program on the east coast, you can watch it half an hour later on the South Australian service or two hours later on the Western Australia service. These channels are freely available to anyone purchasing an "Aurora" system, and there are also over 40 radio stations available.

In certain regional areas of Australia other "commercial" stations operate via satellite, each with their own licensed coverage area.

Seven Central, previously known as "Queensland Television (QTV)" has a license allowing it to broadcast to a satellite audience in areas east of the Western Australia border.

Imparja is an independent broadcaster located in Darwin, carrying a mixture of Network 9, Ten Network, and their own indigenous programming. Their license area also allows coverage east of the WA border.

Golden West Network is a Western Australian broadcaster located in Bunbury WA broadcasting to W.A. satellite viewers only. Win TV is a Network 9 affiliate, licensed to service the WA satellite audience only. There are other services also available such as "Westlink", an educational service provided by the Western Australian government.

SC

***Garry Cratt is technical director of satellite TV equipment supplier Av-Comm Pty Ltd**

Finally, this from the Imparja Television website (imparja.com.au)

RECEPTION AND DISPLAY OF IMPARJA TELEVISION SPORTS EVENTS

Over the past few months Imparja Television has become aware of a number of organisations providing so called "Free to Air" satellite receiving equipment to hotels, pubs and clubs in capital city and regional locations, for the purpose of displaying sports events which are otherwise not available on the "local" free to air TV channels.

Imparja wishes to inform organisations who are supplying or using such equipment that this is ***not permitted.***

Imparja Television is the licensed commercial TV station for Remote Central and Eastern Australia, and under ABA regulations ***may not deliver its signal to locations outside its licence area.*** In addition Imparja only holds the broadcast rights to its programme content ***for its licence area.*** The organisations providing the equipment have no connection with Imparja ***and have no rights to make use of Imparja's broadcast services for any purpose whatsoever.***

The signal being intercepted is a private, point to point link used by Imparja to deliver its signal to the satellite uplink point. Imparja has, and will continue to adopt measures to prevent unauthorised reception of this signal, for specific programme content (particularly sports).

Any organisation outside our licence area that has been advised to purchase equipment for the purpose of displaying Imparja broadcasts is strongly advised to return it to the suppliers and seek a full refund of any money paid.

VINTAGE RADIO

By RODNEY CHAMPNESS, VK3UG

Building A Browning-Drake Replica

Many vintage radio enthusiasts would like to have sets from the 1920s but these are now difficult to obtain. There is an alternative, however – build a replica that's as close to the original design as possible.

Collectors and restorers of old cars, steam engines and, of course, vintage radios, etc all like to have at least one really special item. That item usually takes pride of place in their collection – it can be a real talking point and gives the collector an opportunity to encourage others to take up the hobby.

Wireless/radio sets from the 1920s are often beautiful pieces of furniture that catch the eye. Collectors like to have at least one of these but unfortunately, they are not all that common. As a result, replicas of that era are often made. Often, they look almost identical to the originals, with their construction and performance being similar too.

In fact, the dedication of some constructors is so exacting that many replicas are almost impossible to distinguish from the originals.

This view shows Jim Birtchnell's completed Browning-Drake replica receiver. The hinged lid allows easy access to the circuit components.

During 2000, the Historical Radio Society of Australia (HRSA) decided to promote a constructional project for its members, the idea being to build a replica of a popular "wireless" from the mid-1920s. The set selected was the Browning-Drake tuned radio frequency (TRF) set, a fairly simple receiver consisting of a neutralised RF stage, a regenerative detector and two stages of audio amplification. This circuitry was housed in a "coffin-style" cabinet (see photo) which was almost universally used during the 1920s and into the early 1930s.

Many such replicas were built, with the parts scrounged from all sorts of sources. As a result, they came from many different manufacturers.

Jim's Browning-Drake replica

One member in our local vintage radio club is keen on building replicas from the 1920s. His name is Jim Birtchnell and just recently, he also decided to build a Browning-Drake receiver.

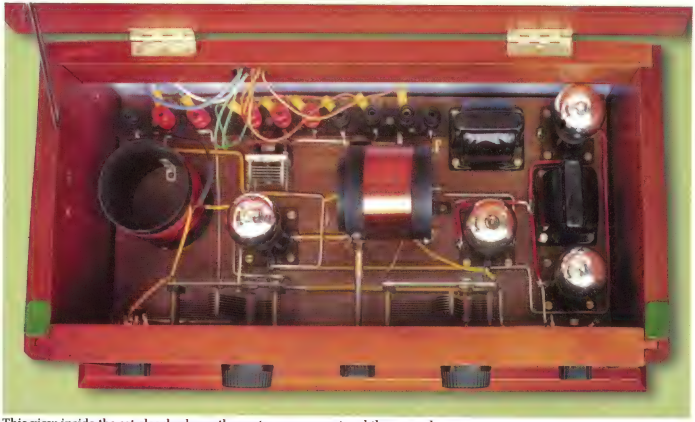
Like all constructors of replicas, Jim needed to scrounge as many parts as possible for his project. These parts either had to be identical or similar to those used in the original receivers. If he couldn't get them, he had to make them.

The cabinet

The cabinet is one of the most important parts in this receiver. The original HRSA specification stated that cabinets could be made from dressed kiln dried timber, 7-ply board, veneered plywood or veneered timber.

Jim selected Kauri timber to make his cabinet and, as can be seen from the photographs, the cabinet is first class. Wood-working is one of Jim's other hobbies, by the way.

The cabinet size is nominally



This view inside the set clearly shows the parts arrangement and the general wiring layout. A lot of the wiring was run using bare square-section busbar, while the coils were wound on 76mm and 57mm-diameter PVC pipe.

530mm long, 275mm deep and 235mm high, while the front panel is made from black Formica. Jim decided to use normal bronze butt-hinges to secure the lid to the cabinet, although it's interesting note that most constructors opt for a piano hinge.

A number of finishes for the cabinet were suggested in the original HRSA articles. These articles even included a complete description of how to prepare the cabinet before applying the final finish coats. Either lacquer or French polish was recommended and there was sufficient detail for constructors to do a good job using either finish.

I must admit that the thought of applying around 30 coats of Shellac, to provide a beautiful French polish, is not something I would look forward to – especially as it's outside my field of expertise. Jim decided to finish his cabinet with Mirotone lacquer, which is an easier alternative to French polishing, and the standard of the finish can be seen in the photos.

The various labels on the set were made by a local screen printer and they too look the part. In fact, the only thing that looks a little out of place on the cabinet is the round power socket that's mounted at the rear. Although there is a row of power supply terminals along the back, Jim decided to also run extended leads from them to the power socket.

This was done so that the set could be powered from an external supply. In fact, Jim uses this same supply to power other replicas which have similar requirements. In short, the external power socket is a matter of practicality.

Circuit details

Obtaining components of the right vintage – or at least looking as though they are of the right vintage – is not an easy task when it comes to building a replica of a set that's about 80 years old. Jim, like most others, had difficulty sourcing some items but his replica still looks very close to the original set.

As shown in the photos, most of the wiring has been done using bare square-section busbar, some of which has been enclosed in coloured spaghetti sleeving. However, a small amount of the wiring was also run in normal plastic-covered hook-up wire where flexibility was needed – eg, the connections to the coils.

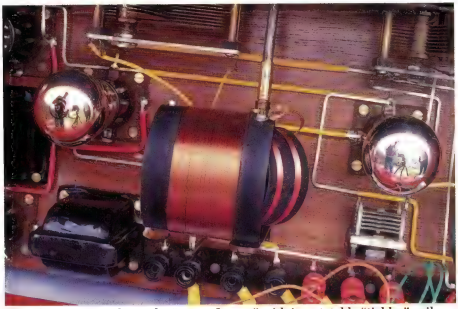
Generally, the wiring has been run parallel to the sides of the case, although there is some point-to-point wiring. "Squared" wiring always looks nice but may not be the most electrically efficient. However, in sets of this vintage, lead dress and length was not often all that important, as each stage had relatively low gain. This meant that the receiver was stable despite poor layout.

Coil formers

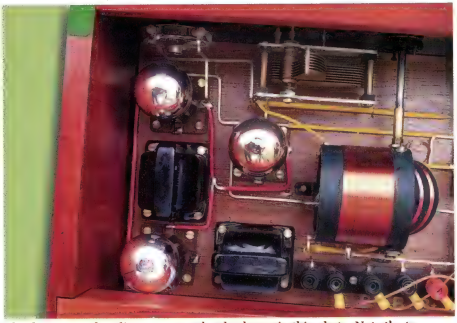
The coil formers were made from white PVC tubing, either three inches (76mm) or two inches (57mm) in diameter. The required lengths of tubing were first cut to length and then spraypainted matt black to give them an authentic look.

The windings on each of the formers were wound on Jim's wood lathe. In this case, ordinary enamelled copper wire was used but other constructors have used double cotton-covered copper wire, which was much more common 80 years ago.

By the way, it's sometimes not a good idea to close-wind enamelled copper wire. That's because the distributed capacitance between the turns can be so high that it restricts the



This close-up view shows the "regenaformer" with its rotatable "tickler" coil for adjusting the regeneration. The RF stage and its associated neutralising capacitor are immediately to the right of the coil.



The detector and audio stages are clearly shown in this photo. Note the two audio transformers.

tuning range to less than the complete broadcast band. To overcome this problem, the HRSA articles recommended that some space be left between turns. However, despite this advice, Jim close-wound his coils and found that the tuning range was quite adequate.

The rotatable "tickler" coil was more difficult to manufacture than the others. This coil was wound on the 57mm pipe and is mounted so that it can rotate inside the 76mm former.

As shown in the photos of the "regenaformer", the "tickler" consists of a split winding on the rotating coil former. This rotating former is in turn attached to a 0.25-inch (6.35mm) shaft which goes through the 76mm former via bushes scrounged from old potentiometers. One of these bushes can be seen on the side of the "regenaformer", nearest the front panel.

The rotating "tickler" coil former is clamped to the shaft to prevent any slippage and also includes a "stop" so that it cannot be rotated more than about 180°.

An important requirement for the "tickler" coil is that its leads must be capable of flexing many thousands of times before breaking. This rules out the use of single-strand wire and even multicore hook-up wire (single-core wire will fatigue and break after only a few bends).

As it turns out, the most suitable cable that's able to withstand repeated flexing is the "tinselled-wire" used in old headphones. In fact, most old headphones still have their original leads and these could be used for the job.

A practical alternative is to use a multi-strand braid cable or any thin cable that has many strands of very fine wire. Jim used copper braid for his set and this has proven to be successful.

The valves

The original Browning-Drake receivers used 201A valves and Jim decided to stick as closely as possible to the original design. The valves were around $A50 each and were obtained from the USA, as was the square section wire and the audio transformer inserts. The HRSA article also suggested a variety of alternative valves that could be used in a replica – eg, the 30 and the A609.

On first seeing the set, I immediately noticed the RF stage neutralising capacitor which had come out of an ex-service VHF transceiver. It was ideal for the job, even if made 20 years later than the original Browning-Drake receivers.

Jim also had some filament rheostats, a high-impedance Philips loudspeaker from the 1930s and some old audio transformers that would suit the set. Unfortunately though, the audio transformers had open circuit windings and so a couple of 1:3 step-up ratio transformers were imported and fitted into the old cases. The tuning capacitors were also in Jim's junkbox and so the set slowly came together over a period of several months.

Circuit details

Fig.1 shows the circuit details of the Browning-Drake receiver. It's a 4-stage TRF design using all 201A valves, the first stage functioning as a neutralised triode RF amplifier.

The antenna coil (L1) is tapped part way up the antenna coil and the antenna circuit is tuned by C2, after which the signal is fed to the grid of

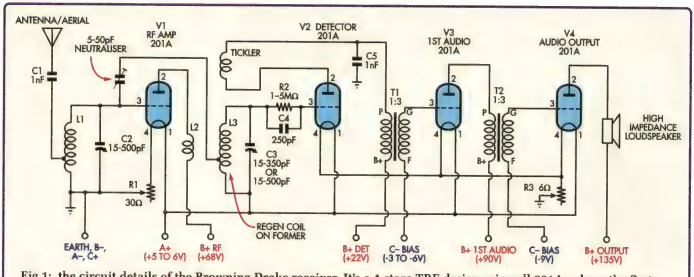


Fig.1: the circuit details of the Browning-Drake receiver. It's a 4-stage TRF design using all 201A valves, the first stage functioning as a neutralised triode RF amplifier.

V1. The resulting signal in V1's plate circuit is then inductively coupled from L2 (primary) to L3 (the tuned secondary winding). The phasing of the primary and secondary is such that the 5-50pF "neutraliser" capacitor feeds back a signal to the grid that is out of phase with the tuned antenna signal.

In practice, the "neutraliser" is adjusted to apply enough signal of opposite phase to cancel the grid-to-plate capacitance of the valve. This is most important if any worthwhile signal amplification is to be achieved in the RF stage.

V2 is a grid leak regenerative detector. The regeneration is controlled by rotating the "tickler" coil within the "regenaformer" until the set oscillates (whistles on any station tuned), then backing off for best performance. The two terminals of the "tickler" may need to be swapped over to obtain regenerative performance.

The output of V2 is then applied to a 1:3 step-up audio transformer and is then fed to V3. V3's output is in turn coupled to V4 via another 1:3 step-up transformer. As can be seen in the photos, the audio transformers are orientated so that there is minimal mutual inductance between them (this is necessary even though they are in metal cases).

The maximum gain of each audio stage will be the normal valve gain

This rear view of set shows the antenna earth and power supply terminals. Note the power socket which allows an external supply to be connected.

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Photo Gallery: Astor "Mickey" Model KL Mantel Radio

Radio Corporation, Melbourne, used the name "Mickey" for almost 20 years on some their Astor mantel receivers from the late 1930s until the mid-1950s. The model KL was introduced in 1946 and used the following valves: 6A8-G frequency changer; 6B8-G reflexed IF amplifier/audio detector/audio amplifier/detector/AGC rectifier; 6V6-GT audio output; and 5Y3-GT rectifier. Later versions used a 6X5-GT rectifier.

A feature of the design was the rather elaborate tone compensation circuitry connected around a tap on the volume control and the loudspeaker voice coil. This resulted in quite good sound from the 5-inch loudspeaker, despite the relatively small Bakelite cabinet.

The KL was available in nine different cabinet colours: walnut, green, blue, champagne, ivory, Chinese red, mahogany, marble champagne and marble ivory. The set illustrated is the less common (today) champagne colour. (Photo: Historical Radio Society of Australia, Inc)

(<8) multiplied by the step-up ratio of the audio transformer (3) – ie, about 8 x 3 =24. This means that two stages will theoretically give an audio gain of 24 x 24 = 576 times. This won't be reached in practice but a healthy 400+ gain is likely.

Alignment and operation

In reality, there is very little alignment and setting up of the set – certainly a lot less than described in the articles I wrote in November 2002, December 2002 and January 2003.

First, the set is connected to a substantial aerial/antenna and earth system and the power applied. That done, you tune to a strong station somewhere near the centre of the dial, peak both tuning controls, then adjust the regeneration control until the set whistles. If it doesn't whistle and advancing the control reduces the audio output, it is likely that the two wires on the "tickler" winding have to be reversed.

Having tuned to the strongest station and peaked the controls, it is time to neutralise the set. However, if the set whistles and screams when the two tuning controls are being brought to a peak, it is likely that the neutralisation is well out of adjustment and the RF stage is going into self-oscillation. If this is the case, you leave the peaking just below the point where the oscillation occurs. Winding back V1's filament voltage (using filament rheostat R1) reduces the gain of this stage and this also helps to stabilise the set.

The next step is to remove the filament supply to V1 so that it is inoperative. However, the station that was being received may still be just audible in the loudspeaker but you will have to use headphones if the stations are not strong in your area.

Now, while listening to the station with the RF stage disabled, you adjust the "neutraliser" for minimum output or, if you are lucky, no sign of the previously tuned station. The set is then neutralised and should now be stable under all circumstances.

It's then just a matter of reconnecting V1's filament supply, after which you should be able to tune and peak the set for best performance. Adjusting the two filament rheostats makes this job just that little bit easier and they do act as volume controls.

The RF stage and its associated neutralising capacitor are shown in this photo. (Note reflection of photographer on the top of the valve).

Summary

Replica sets are an interesting part of the vintage radio hobby. In many cases, a replica is the only way that collector can obtain a particular 1920s receiver.

The performance of these sets is not something to write home about though and they need a substantial antenna and earth system to perform at their best.

Finally, over the last 80 years or so, the names of some components and circuit configurations have changed. There are three such names that stand out in the Browning-Drake receiver: (1) the "neutraliser" which is now commonly called the neutralisation control; (2) the "tickler" which is now commonly called the feedback or regeneration control; and (3) the "regenaformer" which is now known as a regenerative detector coil or Reinartz coil. SC

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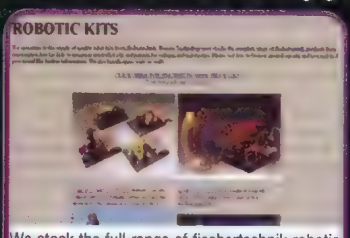

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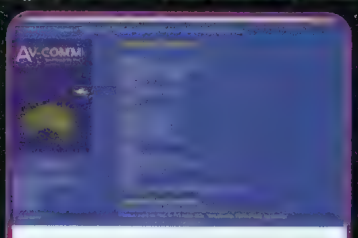

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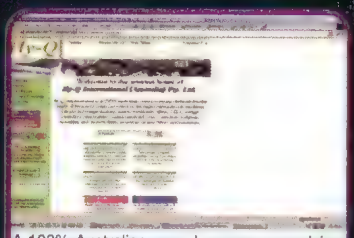

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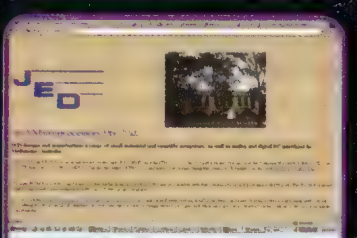

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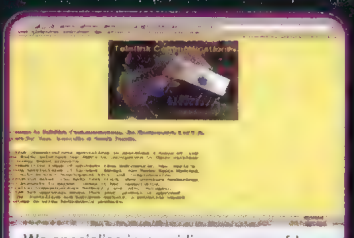

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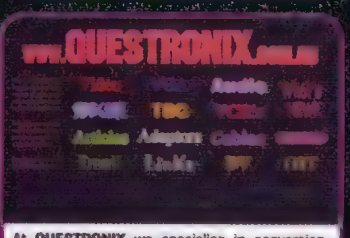

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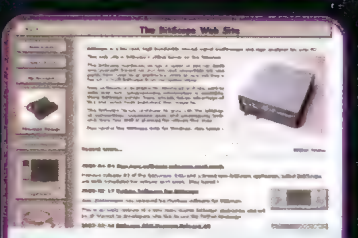

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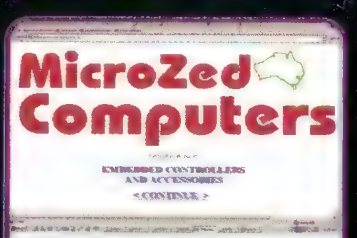

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November 1998: The Christmas Star; A Turbo Timer For Cars; Build A Picker Machine, Pt.1; FM Transmitter For Musicians; Lab Quality AC Millivoltmeter, Pt.2; Improving AM Radio Reception, Pt.1.

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January 1999: High-Voltage Megohm Tester; Getting Started With BASIC Stamp; LED Bargraph Ammeter For Cars; Keypad Engine Immobiliser; Improving AM Radio Reception, Pt.3.

March 1999: Getting Started With Linux, Pt.1; Build A Digital Anemometer; Simple DIY PIC Programmer; Easy-To-Build Audio Compressor; Low Distortion Audio Signal Generator, Pt.2.

April 1999: Getting Started With Linux, Pt.2; High-Power Electric Fence Controller; Bass Guitar Headphone Preamplifier; Thermostat/ Thermometer; Build An Infrared Sentry; Rev Limiter For Cars.

May 1999: The Line Dancer Robot; An X-Y Table With Stepper Motor Control, Pt.1; Three Electric Fence Testers; Heart Of LEDs; Build A Carbon Monoxide Alarm; Getting Started With Linux, Pt.3.

June 1999: FM Radio Tuner Card For PCs; X-Y Table With Stepper Motor Control, Pt.2; Programmable Ignition Timing Module For Cars, Pt.1; Hard Disk Drive Upgrades Without Reinstalling Software?

July 1999: Build A Dog Silencer; 10uH to 19.99mH Inductance Meter; Build An Audio-Video Transmitter; Programmable Ignition Timing Module For Cars, Pt.2; XYZ Table With Stepper Motor Control, Pt.3.

August 1999: Remote Modem Controller; Daytime Running Lights For Cars; Build A PC Monitor Checker; Switching Temperature Controller; XYZ Table With Stepper Motor Control, Pt.4; Electric Lighting, Pt.14.

September 1999: Autonomouse The Robot, Pt.1; Voice Direct Speech Recognition Module; Digital Electrolytic Capacitance Meter; XYZ Table With Stepper Motor Control, Pt.5; Peltier-Powered Car Cooler.

October 1999: Build The Railpower Model Train Controller, Pt.1; Semiconductor Tester; Autonomouse The Robot, Pt.2; XYZ Table With Stepper Motor Control, Pt.6; Introducing Home Theatre.

November 1999: Setting Up An Email Server; Speed Alarm For Cars, Pt.1; LED Christmas Tree; Intercom Station Expander; Foldback Loudspeaker System; Railpower Model Train Controller, Pt.2.

December 1999: Solar Panel Regulator; PC Powerhouse (gives +12V, +9V, +6V & +5V rails); Fortune Finder Metal Locator; Speed Alarm For Cars, Pt.2; Railpower Model Train Controller, Pt.3; Index To Vol.12.

January 2000: Spring Reverberation Module; An Audio-Video Test Generator; Build The Picoxe Programming Board; A Parallel Port Interface Card; Off-Hook Indicator For Telephone Lines.

February 2000: Multi-Sector Sprinkler Controller; A Digital Voltmeter For Your Car; An Ultrasonic Parking Radar; Build A Safety Switch Checker; Build A SineSquare Wave Oscillator.

March 2000: Resurrecting An Old Computer; Low Distortion 100W Amplifier Module, Pt.1; Electronic Wind Vane With 16-LED Display; Glowplug Driver For Powered Models; The OzTrip Car Computer, Pt.1.

May 2000: Ultra-LD Stereo Amplifier, Pt.2; Build A LED Dice (With PIC Microcontroller); Low-Cost 4A Keypad Transducer (Converts IBM Scan-Codes To ASCII); 50A Motor Speed Controller For Models.

June 2000: Automatic Rain Gauge With Digital Readout; Parallel Port VHF FM Receiver; LiI Powerhouse Switchmode Power Supply (1.23V to 40V) Pt.1; CD Compressor For Cars Or The Home.

July 2000: A Moving Message Display; Compact Fluorescent Lamp Driver; El-Cheapo Musicians' Lead Tester; LiI Powerhouse Switchmode Power Supply (1.23V to 40V) Pt.2.

August 2000: Build A Theremin For Really Eerie Sounds; Come In Spinner (writes messages in "hi-sign"); Proximity Switch For 240VAC Lamps; Structured Cabling For Computer Networks.

September 2000: Build A Swimming Pool Alarm; An 8-Channel PC Relay Board; Fuel Mixture Display For Cars, Pt.1; Protoboards – The Easy Way Into Electronics, Pt.3; The Solar Fly.

October 2000: Guitar Jammer For Practice & Jam Sessions; Booze Buster Breath Tester; A Wand-Mounted Inspection Camera; Installing A Free-Air Subwoofer In Your Car; Fuel Mixture Display For Cars, Pt.2.

November 2000: Sunta & Rudolf Christie Display; 2-Channel Guitar Preamplifier, Pt.1; Message Bank & Missed Call Alert; Protoboards – The Easy Way Into Electronics, Pt.3.

December 2000: Home Networking For Shared Internet Access; Build A Bright-White LED Torch; 2-Channel Guitar Preamplifier, Pt.2 (Digital Reverb); Driving An LCD From The Parallel Port; Index To Vol.13.

January 2001: How To Transfer LPs & Tapes To CD: The LP Doctor – Clean Up Clicks & Pops, Pt.1; Arbitrary Waveform Generator; 2-Channel Guitar Preamplifier, Pt.3; PIC Programmer & TestBed.

February 2001: An Easy Way To Make PC Boards; LiI Pulser Train Controller; A MIDI Interface For Pics; Build The Bass Blaser; 2-Metre Groundplane Antenna; The LP Doctor – Clean Up Clicks & Pops, Pt.2.

March 2001: Making Photo Resist PC Boards; Big-Digit 12/24 Hour Clock; Parallel Port PIC Programmer & Checkboard; Protoboards – The Easy Way Into Electronics, Pt.5; A Simple MIDI Expansion Box.

April 2001: A GPS Module For Your PC; Dr Video – An Easy-To-Build Video Stabiliser; Tremolo Unit For Musicians; Minimitter FM Stereo Transmitter; Intelligent Nicad Battery Charger.

May 2001: Powerful 12V Mini-Stereo Amplifier; Two White-LED Torches To Build; PowerPak – A Multi-Voltage Power Supply; Using Linux To Share An Internet Connection, Pt.1; Tweaking Windows With TweakUI.

June 2001: Fast Universal Battery Charger, Pt.1; Phonome – Call, Listen In & Switch Devices On & Off; L'il Snooper – A Low-Cost Automatic Camera Switcher; Using Linux To Share An Internet Connection, Pt.2; A PC To Die For, Pt.1 (Building Your Own PC).

July 2001: The HeartMate Heart Rate Monitor; Do Not Disturb Telephone Timer; Pic-Toc – A Simple Alarm Clock; Fast Universal Battery Charger, Pt.2; A PC To Die For, Pt.2 (Backing Up Your Data).

August 2001: DI Box For Musicians; 200W Mosfet Amplifier Module; Headlight Reminder; 40MHz 6-Digit Frequency Counter Module; A PC To Die For, Pt.3; Using Linux To Share An Internet Connection, Pt.3.

September 2001: Making MP3s – Rippers & Encoders; Build Your Own MP3 Jukebox, Pt.1; PIC-Controlled Mains Switch; Personal Noise Source For Tinnitus Sufferers; The Scooper Snooper Directional Microphone; Using Linux To Share An Internet Connection, Pt.4.

November 2001: Ultra-LD 100W RMS/Channel Stereo Amplifier, Pt.1; Neon Tube Modulator For Cars; Low-Cost Audio/Video Distribution Amplifier; Short Message Recorder Player; Computer Tips

December 2001: A Look At Windows XP; Build A PC Infrared Transceiver; Ultra-LD 100W RMS/Ch Stereo Amplifier, Pt.2; Pardy Lights – An Intriguing Colour Display For Fun – Learning About Micros.

January 2002: Touch And/Or Remote-Controlled Light Dimmer, Pt.1; A Cheap 'n'Easy Motorbike Alarm; 100W RMS/Channel Stereo Amplifier, Pt.3; Build A Raucous Alarm; FAQs On The MP3 Jukebox.

February 2002: 10-Channel IR Remote Control Receiver; 2.4GHz Hi-Fi Power Amplifier Module; Let's Assemble Your Own 2-Way Tower Speakers; Touch And/Or Remote-Controlled Light Dimmer, Pt.2; Booting A PC Without A Keyboard; 4-Way Event Timer.

March 2002: Mighty Midget Audio Amplifier Module; The Itsy-Bitsy USB Lamp; 10-Channel IR Remote Volume Control, Pt.1; RIAA Preamplifier For Magnetic Cartridges; 12/24V Intelligent Solar Power Battery Charger; Generate Audio Tones Using Your PC's Soundcard.

April 2002: Automatic Single-Channel Light Dimmer, Pt.1; Build A Water Level Indicator; Bridge-Output Bench Power Supply; Versatile Multi-Mode Timer; 6-Channel IR Remote Volume Control, Pt.2.

May 2002: 32-LED Knightrider; The Battery Guardian (Cuts Power When the Battery Voltage Drops); Stereo Headphone Amplifier; Automatic Single-Channel Light Dimmer, Pt.2; Stepper Motor Controller.

June 2002: Lock Out The Bad Guys with A Firewall; Remote Volume Control For Stereo Amplifiers; The "Matchless" Metal Locator; Compact 0-80A Automotive Ammeter; Constant High-Current Source.

July 2002: Telephone Headset Adaptor; Rolling Code 4-Channel UHF Remote Control; Remote Volume Control For The Ultra-LD Stereo Amplifier; Direct Conversion Receiver For Radio Amateurs, Pt.1.

August 2002: Digital Instrumentation Software For Your PC; Digital Storage Logic Probe; Digital Thermometer/Thermostat; Sound Card Interface For Test Instruments; Direct Conversion Receiver For Radio Amateurs, Pt.2; Spruce Up Your PC With XP-Style Icons.

September 2002: 12V Fluorescent Lamp Inverter; 8-Channel Infrared Remote Control; 30-Watt DC Electronic Load; Driving Light & Accessory Protector For Cars; Spyware – An Update.

October 2002: Speed Controller For Universal Motors; PC Parallel Port Wizard, "Whistle & Point" Cable Tracer; Build An AVR ISP Serial Programmer; Ultra-LD 2 x 30W Hi-Fi Amplifier Module.

November 2002: SuperCharger For NiCd/NiMH Batteries, Pt.1; Windows-Based EPROM Programmer, Pt.1; 4-Digit Crystal-Controlled Timing Module; Using Linux To Share An Optus Cable Modem, Pt.1.

December 2002: Receiving TV From Satellites, Pt.1; The Micromite Stereo FM Tuner; Windows-Based EPROM Programmer, Pt.2; SuperCharger For NiCd/NiMH Batteries, Pt.2; Simple VHF FM/AM Radio; Using Linux To Share An Optus Cable Modem, Pt.2.

January 2003: Receiving TV From International Satellites, Pt.2; Reader Programmer For Serial EEPROMs; SC480 50W RMS Amplifier Module, Pt.1; A "Tiptronic-Style" Gear Indicator; Active 3-Way Crossover For Loudspeakers; Using Linux To Share An Optus Cable Modem, Pt.3.

February 2003: The PortaPal Public Address System, Pt.1; 240V Mains Filter For HiFi Systems; SC480 50W RMS Amplifier Module, Pt.2; Windows-Based EPROM Programmer, Pt.3; Using Linux To Share An Optus Cable Modem, Pt.4; Tracking Down Elusive PC Faults.

March 2003: LED Lighting For Your Car; Peltier-Effect Tinnie Cooler; PortaPal Public Address System, Pt.2; 12V SLA Battery Float Charger; Build The Little Dynamite Subwoofer; Fun With The PICAXE (Build A Shop Door Minder!); SuperCharger Addendum; Emergency Beacons.

April 2003: Video-Audio Booster For Home Theatre Systems; A Highly-Flexible Keypad Alarm; Telephone Dialler For Burglar Alarms; Three Do-It-Yourself PIC Programmer Kits: More Fun With The PICAXE, Pt.3 (Heartbeat Simulator); Electric Shutter Release For Cameras.

May 2003: Widgybox Guitar Distortion Effects Unit; 10MHz Direct Digital Synthesis Generator; Big Blaster Subwoofer: Printer Port Simulator; More Fun With The PICAXE, Pt.4 (Motor Controller).

PLEASE NOTE: Issues not listed are now sold out. All other issues are presently in stock. We can supply photostat copies (or tear sheets) from sold-out issues for $8.80 per article (includes p&p). When supplying photostat articles or back copies, we automatically supply any relevant notes & errata at no extra charge. A complete index to all articles published to date can be downloaded free from our web site. **www.siliconchip.com.au**

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Home welder control circuit

I have a CIG Metalcraft home welder, 240VAC 10A in, 105A output, with no adjustment. It occurs to me that it would be quite easy to reduce the current on the input side of the transformer to give me an adjustable output. Could I use or modify one of your circuits to do the job? (F. C., via email).

● In principle, you could use a high power light dimmer to alter the output of your welder. The appropriate circuit to use would be the high power dimmer published in the August 1994 issue of SILICON CHIP. This used a snubber network across the Triac. This is necessary to provide reliable commutation (switching) of the Triac when driving the transformer load of your welder.

We can supply the August 1994 issue for $8.80 including postage.

Can old LCD monitors be recycled?

I have a number of old laptops that are not worth the trouble to repair but they have good working colour LCD displays which I would like to reuse with desktop PCs. So far I have not been able to get any information from the manufacturers and all the repair shops around here say it is too hard.

I understand that it would require a separate power supply and a few other bits so that it could be plugged into the video port on a desktop PC. I would appreciate any info or help that you could supply in regard to this interesting problem. I also think that it would make a worthwhile article for your magazine. (G. M., via email).

● The reason the repair shops say it is too hard is because it is too hard. This question is often asked on the Internet computer and electronics newsgroups and invariably the answer is the same: it's too hard. Laptops all use proprietary chips to drive their displays – it is not simply a matter of feeding in a VGA signal at the right point. And each brand (and even models within each brand) is different.

For this reason, an article along the lines you suggest is not practical. In our "Serviceman's Log" column in September 2002, the opposite problem to what you have was covered – ie, notebook working but broken LCD – but apart from that we have no further information available on notebook LCDs.

Brownout detector to protect AC motors

Have you ever described a "brownout" detector which can monitor the 240VAC mains for low voltage and also for high voltage; ie, <225VAC and >250VAC.

The current ES standards are 230VAC +10% -6% (216 - 253VAC). ETSA in SA (which was privatised in 2000 so that we are now "enjoying" the highest electricity prices in Australia) has stated that it will "hold" the minimum to 225.6V AC. This is NOT happening and every time we have a "hot" spell many consumers suffer losses of their appliances due to low voltages in the network.

As you can appreciate, such a device is invaluable to monitor low mains voltages in particular. It should preferably be in series with the appliance such as a refrigerator and turn it off when the voltage is low. It would issue an alarm so that the householder can switch off all other appliances with electric motors.

Ordinarily only the fridge will be on and unattended (ie, no one at home). All other appliances with motors (washing machines, dishwashers, air conditioners etc) should NOT be left on and unattended; that is the theory anyway.

The second item that comes to mind is a computer/hifi AC line filter which should include an LC line filter plus varistors (MOVs) across A-N, A-E, and N-E for high voltage spikes. It should also protect the phone line (modems) with a gas arrestor device.

As varistors are subject to gradual deterioration, some kind of indicator should be included to show when they need to be replaced. I am aware that power boards are available which pur-

Extending the IR extender

Some time ago I purchased a Remote Control Extender kit, as described in the July 1996 issue of SILICON CHIP. While the unit works fine, I find that the operational range of the IR transmitting diode is only around 1.2m. I have played around with VR1 but this is the best range I can achieve. I have an application where I would like to mount the IR transmitter around 3.5m away from my stereo and was wandering whether it is possible to extend the range to a similar range of my stereo's remote control.

I do not have access to an oscilloscope but have used a multimeter to test the voltage and current of the IR diode while operating. The diode is drawing around 3-5mA during transmission. The Dick Smith Electronics reference material suggests that normal operation should be around 20mA with a maximum of 50mA. Is it possible to increase the output of this diode by reducing the resistance of the 220Ω resistor at the collector of Q1? (P. B., via email).

● The current through the LED is 40mA and so increasing the current could damage the IRLED. Further range could be achieved by paralleling more IRLEDs, each with their own 220Ω resistor in series. Also you could try adding a torch reflector behind the LEDs to give a more concentrated beam of IR light.

port to do this and Dick Smith Electronics sells a device which also "protects". Can you advise on these questions please? (J. C., via email).

● SILICON CHIP has not described one but EA described a Brownout Detector in the March 1983 issue. This circuit includes a relay to switch off the load, if the voltage drops below a preset threshold such as 220VAC. It also includes a LED but does not include an audible alarm. This could be easily added though, in the form of a piezo alarm with inbuilt oscillator, connected across the relay coil.

Note also that the above circuit does not indicate or switch off for voltages above the normal range and we wonder why you would want to do that anyway. The only real hazard of slightly higher than normal mains voltages is shorter life for incandescent lamps and perhaps for stove elements.

We can supply a photostat copy of the EA Brownout Detector article for $8.80, including postage.

We described a mains filter for hifi and computer gear in the February 2003 issue of SILICON CHIP but it did not include protection for phone equipment.

Oxygen sensor for mixture display

In the September 2000 edition of SILICON CHIP you had a Mixture Display project. The oxygen sensor used was a Bosch LSM11 (Part No. 0258104002). I am trying to source one secondhand from the wreckers. To what make and model vehicles was this sensor fitted? What is the cost of a new sensor? (R. F., via email).

● We do not recommend using the Bosch sensor as this is too expensive. We suggest you obtain a secondhand sensor from a late model Commodore.

EPROM Programmer teething problems

I've just built the Dick Smith Electronics kit version of your latest EPROM Programmer.

While it does work, it seems to have some intermittent problems. I am using M27C1001-15F1 EPROMs with the configuration program supplied in your zip file. However, I randomly get programming failures for no apparent reason. I am checking for complete erasure before I start programming.

Also, if I say yes to "verify" after programming or try to do a verify on its own, I always get a "run time error 6 overflow" message. I've tried various PCs from a Pentium 133 to Pentium 1GHz. I seem to get the least problems when I set the port to SPP in the BIOS. Despite SPP being set in the BIOS, the Win98 device manager still reports it as an ECP port, even after a restart or trying to make it detect the "new" hardware.

I've checked the board several times and have not found any assembly errors and have checked all the voltages. Clocks are at 4, 2 and 1MHz but the waveform do not appear perfectly square; is this part of the problem?

I bought a new 25-pin cable to connect it to the PC but unfortunately the first one I picked up was some sort of DOS6 crossover cable which was quickly replaced with a proper straight-through cable. I don't think the wrong cable caused any damage – the voltages were the same before and after the mistake. Any advice you could give would be most appreciated! (V. P., via email).

● From your description of the symptoms you're getting, we don't think there's anything wrong with your EPROM Programmer hardware. The voltages seem OK, while the waveforms for the clock signals don't have to be a perfect square wave.

New Speed Alarm For Cars Required

Here's a quick idea for a SILICON CHIP project. It's a speed alarm that beeps when you've exceeded the speed limit. You've done one in the past but this is slightly different.

As I see it, the problem is that these days, there are too many different limits. On my way to work, for example, I start in a 60 zone, go to 40, back to 60, up to 70, back to 40, up to 80, back to 60, then 70 and I've only travelled a few kilometres! Therefore to be useful, a speed alarm should have preset values built-in – 40, 50, 60, 70 & 80km/h – that can be cycled through easily simply by tapping a footswitch mounted to the left of the clutch pedal. A short push on the switch would step the unit up, a longer press could step it down.

The unit would have two displays, one showing the selected limit, the other showing actual speed, with a beeper sounding when the selected limit is exceeded.

Hope you find the idea useful. If you do, there's no need to credit me. You can take all the glory, 'cause you're going to have to do all the hard work! (G. B., via email).

● Our Speed Alarm published in the November & December 1999 issues does almost all you want except that its speed setting is incremented in 5km/h steps instead of 10km/h. It would probably be a simple matter to change the software to give 10km/h steps.

Apart from that, we think providing a second display to show the vehicle speed setting is a little over the top – after all most cars already have a speedo! However, the display can be switched between alarm and vehicle speed.

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Parts source for 40V 8A supply

I'm intending to build the 40V 8A Power Supply described in April & May 1998 issues of SILICON CHIP. I have located sources for most of the components except for the BUK436-200A Mosfets, the 150V 3W zener diodes and the transformer assemblies (ETD44 & ETD-34).

Can you give me any clues where I might be able to obtain these components or suggest possible alternative components that I could source? I tried Farnell for the Mosfet but an electronic search through their catalog came up blank.

Does the zener diode need to be 150V? The 75V types seem to be more commonly available; will two of these in series do the job? (K. T., Canberra, ACT).

● The BUK436-200 can be replaced with an STP19NB20 (Farnell Cat. 332 8156), while the 150V zener can be the BZT03-C150 (Farnell 368-519).

The ETD34 and ETD44 transformer assemblies are also available from Farnell – see catalog page 602 or their website under transformers (Ferroxcube ETD34 and 44).

You may need to experiment further with printer port settings in the BIOS, perhaps, in order to get more reliable operation. Another reader has also found that his machine doesn't have the DLL file VBA6.DLL, which the programming software may need (although the VB6 packaging and distribution utility we used to prepare the software package to put on the SILICON CHIP website hasn't included this in the package, which suggests that it isn't needed).

You may also like to check the manufacturer's data on the exact EPROMs you're trying to program – just in case the settings (like programming pulse width) that are in the sample 27C1001 device configuration file are not quite right for your devices.

Speed control for sewing machines

I have just built the 5A speed control published in the October 2002 issue of SILICON CHIP. I need to build a number of these to control the sewing machines in our factory. However, while the control works quite well, it does not allow the motor to run at full speed. Is there any modification I can do to achieve this? I need the control to work from about half speed to full speed. (P. B., Clayton, Vic).

● As shown in the scope waveforms of page 18 of the October 2002 issue, the maximum voltage delivered to the motor is around 170V. This is to be expected because when set for maximum output, the circuit can be regarded as an ordinary power diode. That is why we included the bypass switch, so that the full 240VAC could be applied to the motor when needed.

Hence, there is no modification to this circuit which will allow speed control over a range from half speed to full speed. Since sewing machine motors draw only a modest current, you could consider using a modified light dimmer circuit. This would need to include an RC snubber circuit to allow proper commutation of the Triac when driving the inductive load of the motor. The snubber circuit is connected directly across the Triac and would typically consist of a 1kΩ 1W resistor in series with a .01μF 250VAC capacitor.

However, while this approach will give you speed control up to the maximum, it will not have good load/speed regulation which you would probably want, considering the varying loads likely to be encountered when driving a sewing machine. Therefore the only solution is to build the full range speed control featured in the November 1997 issue of SILICON CHIP. This is a bit like using a sledgehammer to crack a walnut, because of its maximum current rating of 10A but there is no other published circuit which will do the job.

We can supply the November 1997 issue for $8.80, including postage and packing.

Thermocouple temperature control

I have an incubator that had a thermistor-controlled temperature relay. When this failed (open-circuit) the element stayed on and burnt out. I have looked at all temperature control devices available but they are all thermistor-controlled.

Is there a circuit driven by a thermocouple that's failsafe; ie, that switches the element OFF if the thermocouple goes open-circuit? (G. A., via email).

● We have not published any temperature control circuits using a thermocouple although you could use the Thermocouple Adaptor published in the December 1998 issue as the "front end" of a temperature-controlled circuit.

Sub Bass Processor power supply

I am wanting some information about the Sub Bass Processor described in the September 1999 issue of "Electronics Australia". I am running it in a system made up of two of the 50W amplifier modules described in the March 1994 issue of SILICON CHIP.

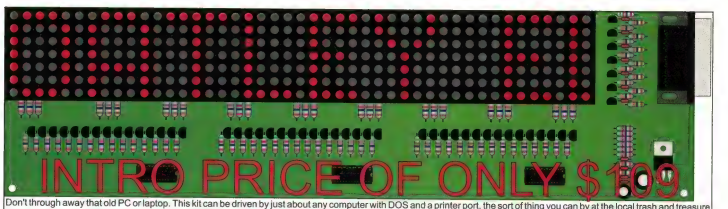
I am wondering what is an appropriate value for the dropping resistors in line with the power supply rails to run the processor off the amplifier's ±35V rails. (M. R., via email).

● The Sub-Bass Processor actually has provision on the PC board for two 3-terminal regulators to provide the ±15V rails from the higher DC supply rails of a power amplifier. This is shown on a small diagram on page 54 of the September 1999 EA article. You can feed these regulators from the ±35V rails of the 50W amplifier module via dropping resistors of around 220Ω 1W.

Knightrider project snuffs out

I built the PIC-controlled 32-LED Knightrider described in the May 2002 issue. When I apply power to it, and when I either increase the brightness or speed of the LEDs, the pattern which it was suppose to display does not function or work properly. The only change I made was upgrading the 5mm LEDs to 10mm bright LEDs. (P. N., via email).

● We think the power supply you are using cannot cope with the load drawn by the Knightrider circuit. So when you increase brightness or speed, both of which will increase the current requirement, the regulator begins to lose



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(USED) BWD 603B FUNCTION GENERATOR MINI-LAB: More info on our web site $260 (zc0211)

(USED) ROHDE & SCHWARZ SMS SIGNAL GENERATOR: Outputs 0.1 to 520MHz. $650 (zc0214)

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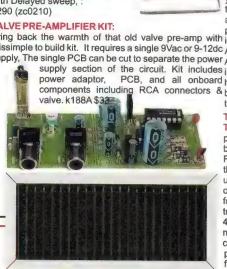

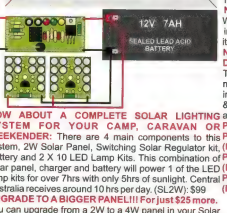

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Ultra-LD amplifier has low sensitivity

I have at last completed building a stereo Ultra-LD amplifier with loudspeaker protection, as featured in SILICON CHIP, in March, May and August 2000. It is cool-running, silent and has crystal-clear sound. I'm very pleased with the result, thank you. I measured 114W on each channel into a 7Ω resistor.

However, I have the distinct impression from listening that none of my audio sources can drive each amplifier to 100W at 0dB. For example, music played from ABC's Classic FM station is set at -5dB for general background listening. A CD of Richard Strauss's "Thus Spake Zarathustra" is a good test of dynamic range. Yes, the sound was loud but not overly so.

Commercially recorded tapes produced a similar sound intensity. The sound level achieved is adequate for all my purposes and I like the idea of having the volume control near 0dB. But I would also like the amplifier to be able to reach its full output should the need arise.

I could install an op amp with a gain of 2 after the volume control with in/out switching but before I do that, would you kindly clarify your design decision on an input sensitivity of 1.8V for 0dB full output? (G. C., Palmwoods, Qld).

● We originally set the sensitivity of the Ultra-LD amplifier at 1.8V to limit the possibility of overload on CDs. In typical situations, with pop, jazz and rock music, the sensitivity is generally more than adequate but it can be a little low on soft passages in classical and opera.

The solution is to build the preamp featured in the later version of the Ultra-LD 100, in the November & December 2001 issues. This was revised in June & July 2002, to go with a remote motorised volume control. We can supply these issues for $8.80 each, including postage.

its 5V supply output and the PIC resets itself. Try a power source which can deliver more current than the one you are using. Alternatively, try changing the 7805 used for REG1 to an LM2940T-5 regulator. This has a lower dropout voltage and may solve the problem without changing the power source. The regulator is available from Dick Smith Electronics (Cat. Z-6600).

Music effects box wanted

I was wondering if you have ever published a kit for producing effects like echo, reverb, flanger, phaser, chorus effects etc, that can be used with line levels (CD output, mixer output). I need this to plug in the mixer output and then control the line level output to the amplifier.

Also, I was after a kit that does the reverse of a karaoke kit; ie, removes the music and leaves the vocals only. Have you ever produced a kit like this? (R. L., via email).

● For a music effects box, have a look at the Digital Effects Processor published in the February 1995 issue of SILICON CHIP. As far as cancelling the music and leaving the vocal, that is not possible. You can have a look at the Vocal Canceller published in the April 1982 issue of "Electronics Australia". That circuit effectively cancels the in-phase components of the left and right channels to remove the centre vocal sound and leave a rather anaemic L-R signal. But you can't do the opposite and end up with no vocal and the instruments unchanged.

We can supply a photostat copy of the EA article and the SILICON CHIP magazine, for $8.80 each, including postage.

Identifying a dead component

I'm fixing a high power amplifier which may have been one of the Playmaster series. The output stage contains three 2SK133 and 2SJ48 Mosfets, if that's any help.

Anyway, there is a shorted component which I cannot identify. It looks like a zener or signal diode (it has the clear & orange glass body) and is marked C19. Judging by its physical size, I would say it's about a 1/2-watt device.

I've tried looking in the Farnell and WES catalogs but nothing with C19 in the device part number seems to be listed. I can't think of anybody better to ask than yourselves as to what this device may be.

If it's blatantly obvious please accept my apologies; I have never been any good at decoding semiconductor markings! (R. M., via email).

● The failed component is almost certainly a zener diode, rated at around 12V. There would normally be two on the board and each connected in series with a 1N914. These would be used to limit gate drive to the Mosfets.

We can't place the amplifier but might be able to help further if you can identify the PC board code.

Notes & Errata

Printer Port Simulator, May 2003: the PC board code should be 07105031, not 04105031. **SC**

WARNING!

SILICON CHIP magazine regularly describes projects which employ a mains power supply or produce high voltage. All such projects should be considered dangerous or even lethal if not used safely. Readers are warned that high voltage wiring should be carried out according to the instructions in the articles. When working on these projects use extreme care to ensure that you do not accidentally come into contact with mains AC voltages or high voltage DC. If you are not confident about working with projects employing mains voltages or other high voltages, you are advised not to attempt work on them. Silicon Chip Publications Pty Ltd disclaims any liability for damages should anyone be killed or injured while working on a project or circuit described in any issue of SILICON CHIP magazine. Devices or circuits described in SILICON CHIP may be covered by patents. SILICON CHIP disclaims any liability for the infringement of such patents by the manufacturing or selling of any such equipment. SILICON CHIP also disclaims any liability for projects which are used in such a way as to infringe relevant government regulations and by-laws.

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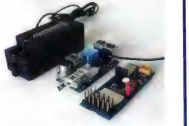

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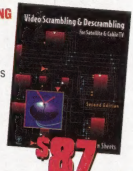

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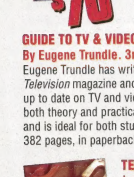

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